DOCUMENT RESUME

ED 096 549 CE 002 190

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TITLE	A Self-Instructional Program in Graphical Kinematics.
INSTITUTION	Lincoln Land Community Coll., Springfield, Ill. Div. of Mathematics, Sciences, and Technologies.
PUB DATE	Jul 72
NOTE	51p.; For related document see CE 002 187
EDRS PRICE	MF-$0.75 HC-$3.15 PLUS POSTAGE
DESCRIPTORS	*Autoinstructional Aids; Force; *Mechanics (Physics); Mechanics (Process); *Motion; Programed Materials; *Programed Texts; Textbooks
IDENTIFIERS	*Graphical Kinematics; Peaucellier's Mechanism

ABSTRACT

The self-instructional booklet is designed to teach basic concepts of graphical kinematics if a step-by-step procedure is followed through the various frames. Each frame is composed of three main parts: (1) a statement of information, (2) a problem to be solved or a statement to be answered, and (3) the correct response. The answer sheet form and a posttest are appended. (Author/AJ)

A SELF-INSTRUCTIONAL PROGRAM IN GRAPHICAL KINEMATICS

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July 1972

OBJECTIVES

After satisfactorily completing all the frames in this booklet the reader should be able to:

1. recognize a Peaucellier's mechanism.

2. recognize a modified Peaucellier's mechanism.

3. recognize an inverted Peaucellier's mechanism.

4. indicate selected link ratios required in order to have a Peaucellier's mechanism, a modified Peaucellier's mechanism, and an inverted Peaucellier's mechanism.

5. state which links in a Peaucellier's mechanism, a modified Peaucellier's mechanism, and an inverted Peaucellier's mechanism have linear or angular motion.

6. state which linkage ratios cause point path curvature in a modified Peaucellier's mechanism.

7. indicate selected point relationships as motion is introduced into a Peaucellier's mechanism, a modified Peaucellier's mechanism, and an inverted Peaucellier's mechanism.

8. graphically analyze a Peaucellier's mechanism, or a modified Peaucellier's mechanism, or an inverted Peaucellier's mechanism.

DIRECTIONS

This programed booklet is designed to teach basic concepts of graphical kinematics if a step by step procedure is followed through the various frames. You are to proceed through the entire program. If you skip frames or fail to read each frame carefully, you may find yourself confused or unable to understand later frames.

Each frame is composed of three main parts; (1) a statement of information, (2) a problem to be solved or a statement to be answered, and (3) the correct response.

The booklet is not to be read like a conventional book. Each page is divided into a statement of information and problem to be solved or a statement to be answered. Frame one appears on page one, frame two on page two, etc. After you read the statement of information and WRITE YOUR RESPONSE ON THE ANSWER SHEET, turn the page and check your response with the correct answer shown on the back. Proceed on to the next frame, read the statement, make your response, and turn the page to check the answer. Repeat this process until you complete the entire booklet.

You are to follow these rules to successfully complete the program:

1. Begin the program with Booklet One and carefully read each frame.

2. Each frame contains one or more blanks. Each blank indicates a missing word to be completed. Write the answer to each frame in the space provided on the answer sheet. DO NOT WRITE ON THE BLANK IN THE FRAME. The correct response to each frame appears on the following page.

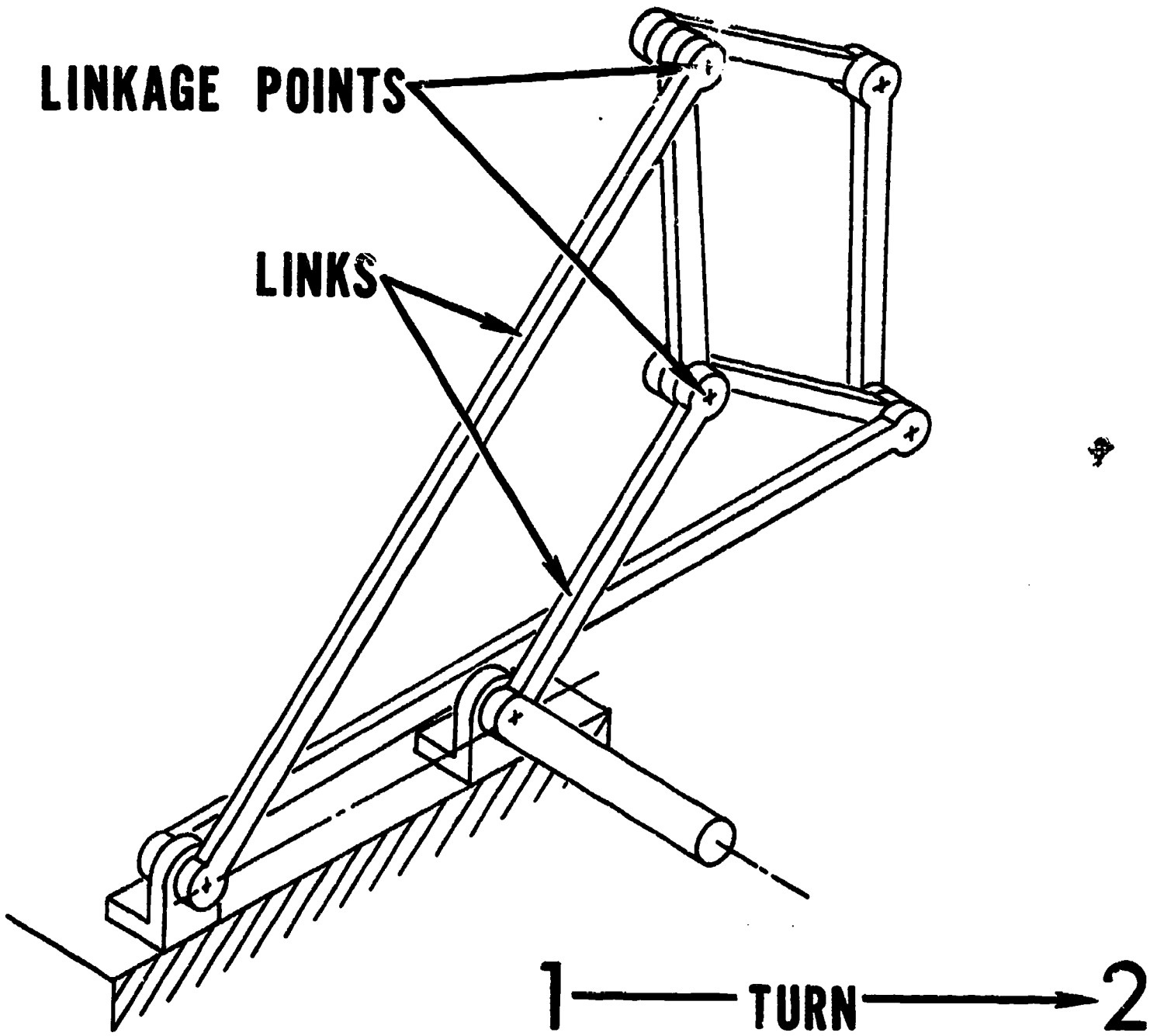
3. If you do not respond satisfactorily to a frame, try to determine the cause of the error before proceeding to the next frame. If your response is incorrect, DO NOT ERASE, BUT DRAW A LINE THROUGH IT AND WRITE THE CORRECT RESPONSE ABOVE IT ON THE ANSWER SHEET.

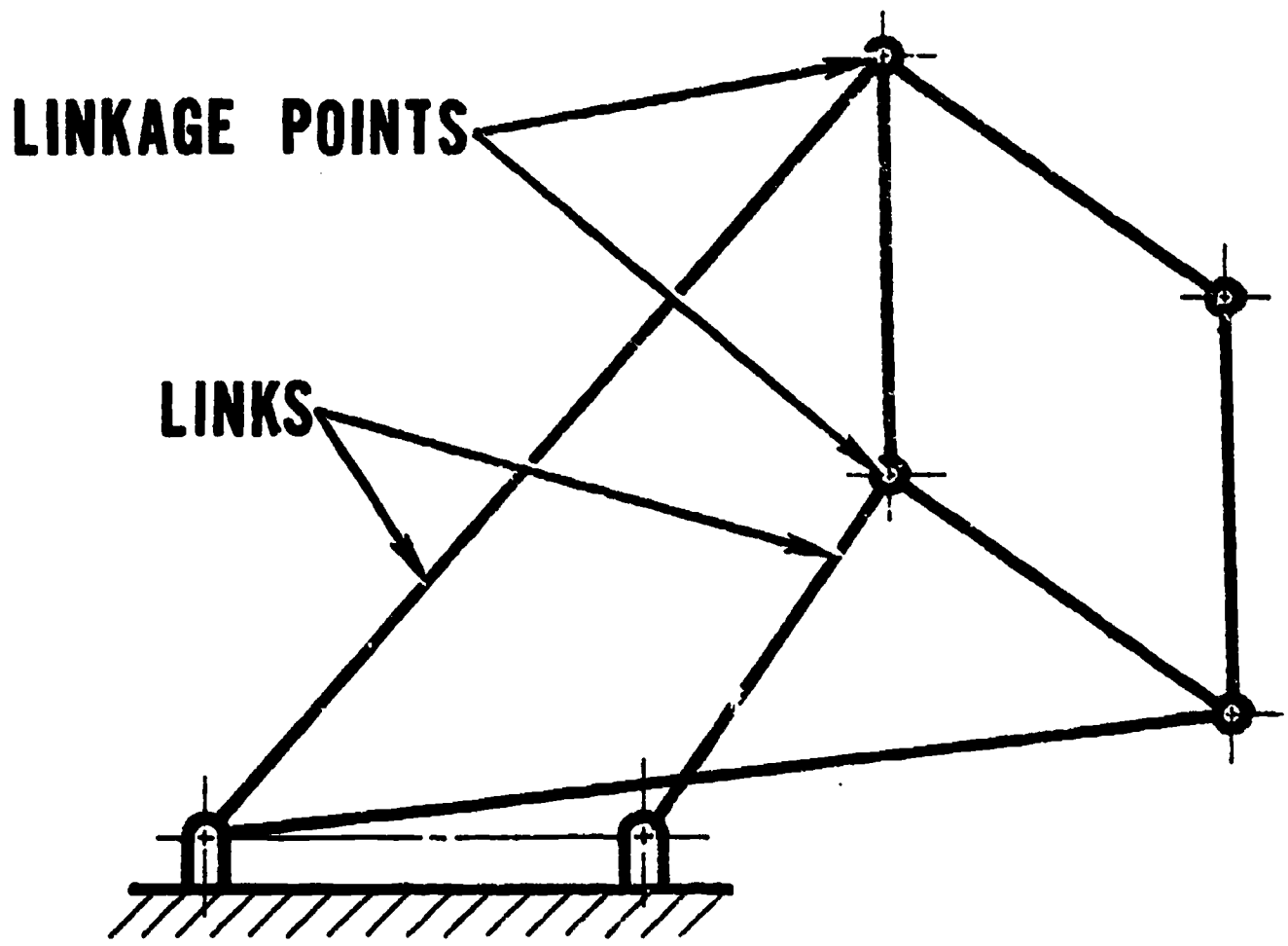
4. Record the starting and finishing times for the program segments to the nearest minute in the spaces provided.

5. The answer sheets are in the back of each booklet. Tear out the answer sheet and begin. GOOD LUCK.

Illustration (1) shows a complete mechanism which is made up of LINKS and LINKAGE POINTS. Illustration (2) shows a KINEMATIC form of the same mechanism. This program will use some kind of KINEMATIC FORM to show LINKS and LINKAGE POINTS.

I will be studying a mechanism made up of <u>(a)</u> and <u>(b)</u> <u>(c)</u>. It will be in <u>(d)</u> FORM



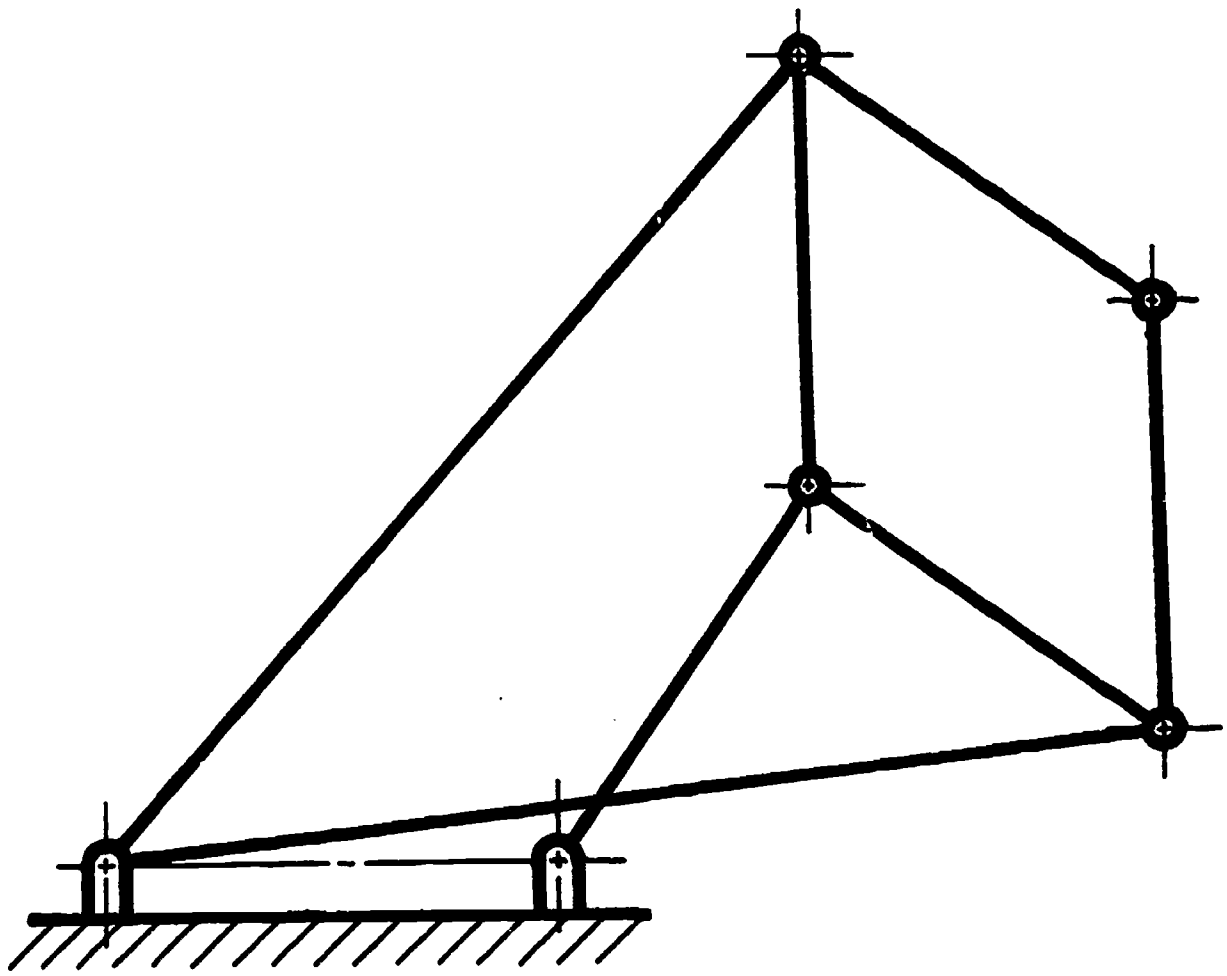


2

FRAME 2.2.

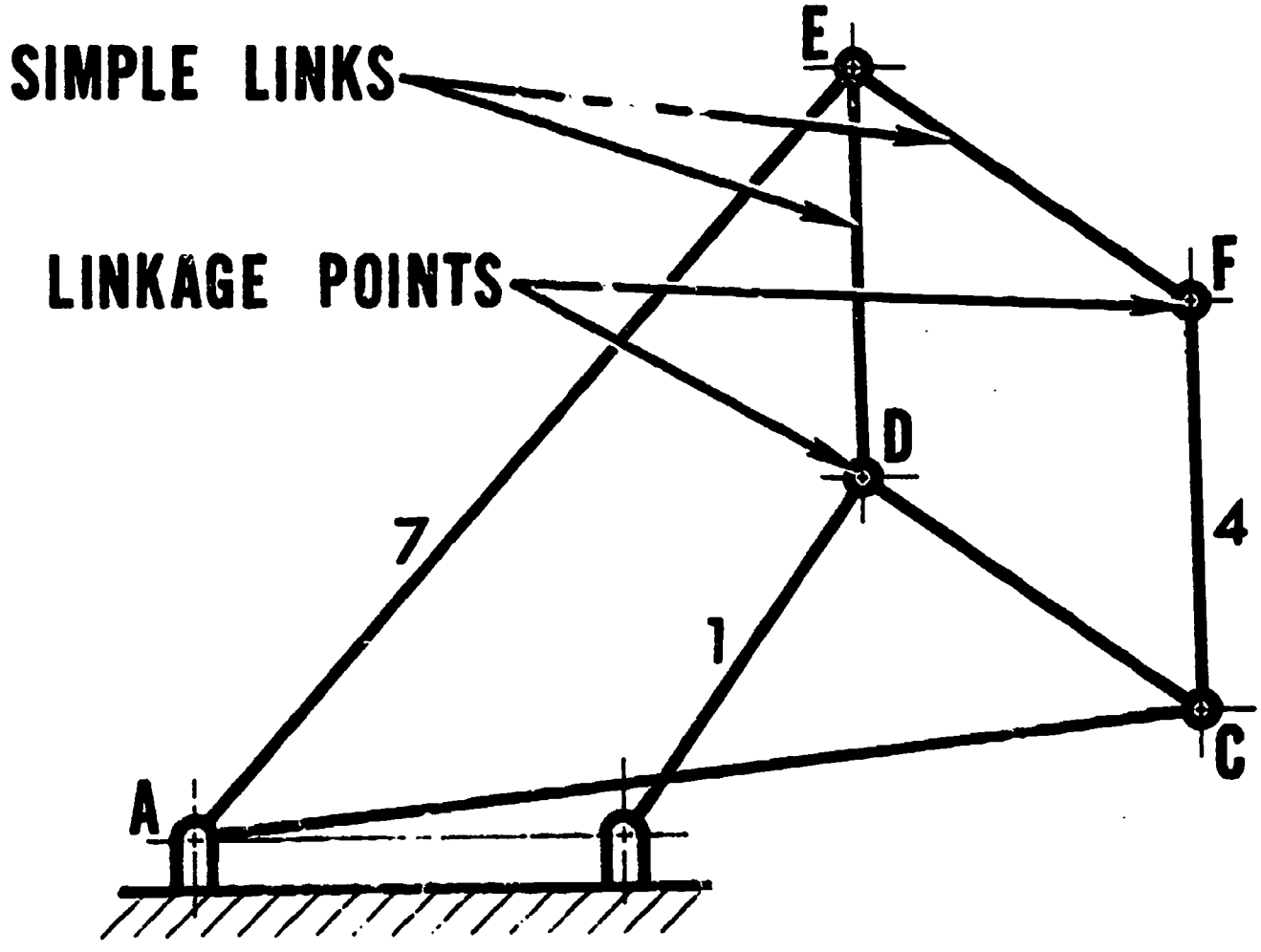
The KINEMATIC FORM illustrated shows a PEAUCELLIER'S mechanism. This is the first specific KINEMATIC FORM that you will be studying in this booklet.

I will be studying a specific KINEMATIC FORM called a(an) __(a)__ mechanism.



The PEAUCELLIER'S mechanism is made up of connected LINKS. These links are rigid members connected by moveable LINKAGE POINTS. Each LINK is called a SIMPLE LINK because it has only two LINKAGE POINTS.

Point "C" is called a (a) (b).
Line 7 is called a (c) (d).
Point "E" is called a (e) (f).
Line 4 is called a (g) (h).
Point "D" is called a (i) (j).
Line 1 is called a (k) (l).
Point "F" is called a (m) (n).

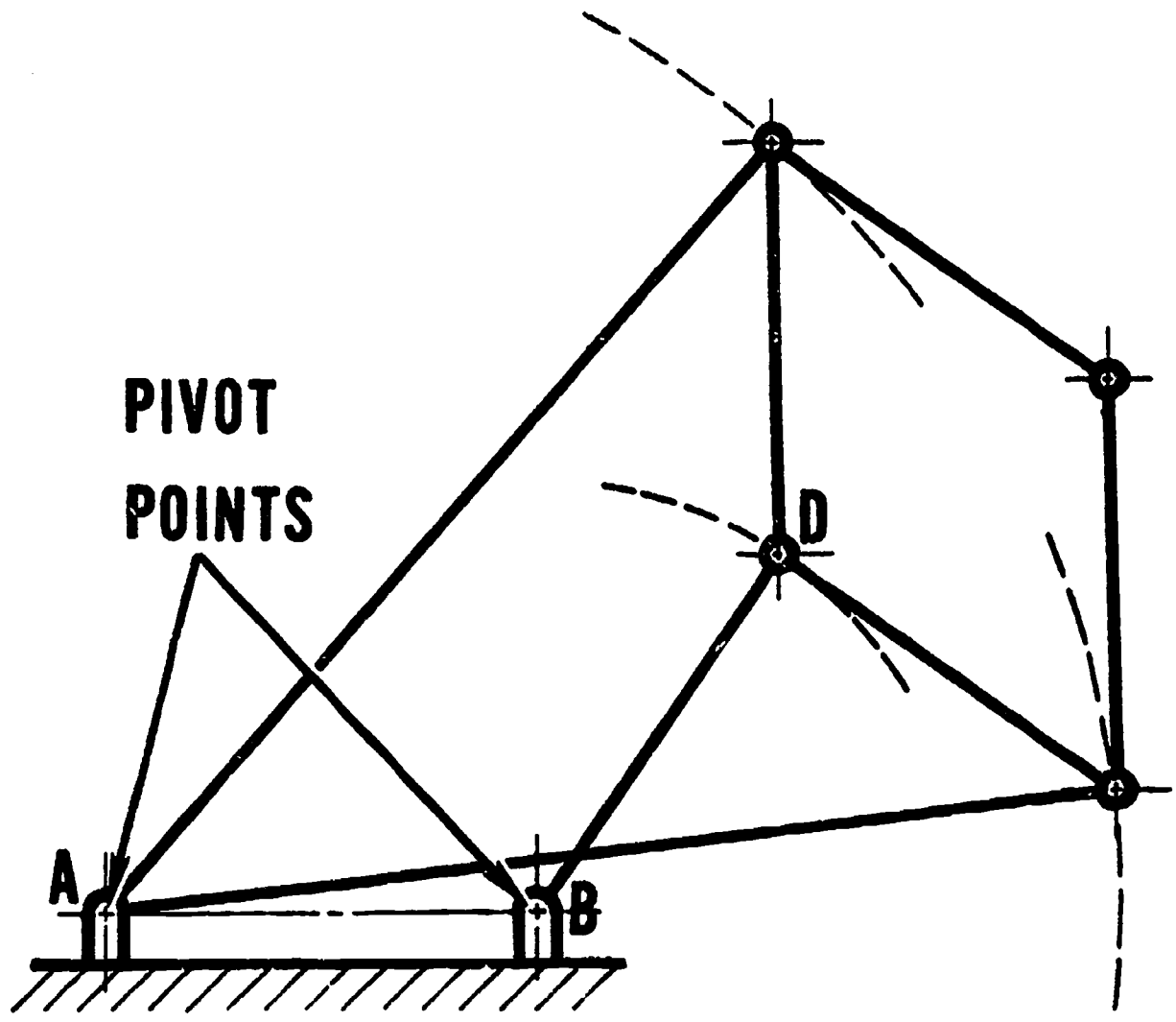


FRAME 4.4.

The PEAUCELLIER'S mechanism you are studying has points called PIVOT POINTS. All SIMPLE LINKS attached to these PIVOT POINTS will revolve.

The __(a)__ mechanism I am studying is made up of SIMPLE __(b)__, LINKAGE __(c)__ and PIVOT __(d)__.

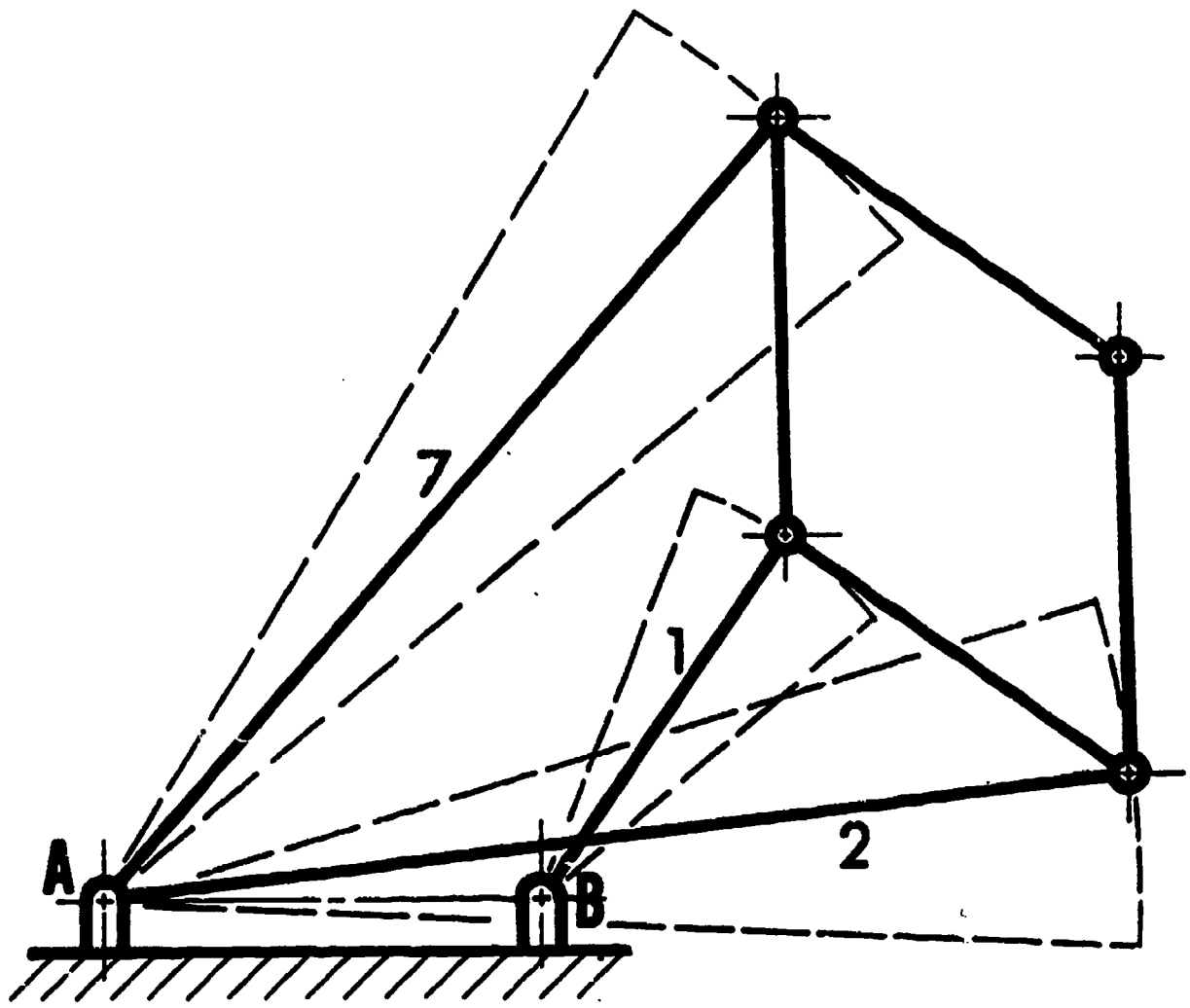
Point "A" is called a __(e)__ __(f)__.
Point "D" is called a __(g)__ __(h)__.
Point "B" is called a __(i)__ __(j)__.



FRAME 5.5.

The SIMPLE LINKS attached to PIVOT POINTS "A" and "B" revolve and as a result have ANGULAR DISPLACEMENT.

Links (a), (b) and (c) revolve about PIVOT POINTS "A" or "B" and have (d) DISPLACEMENT.

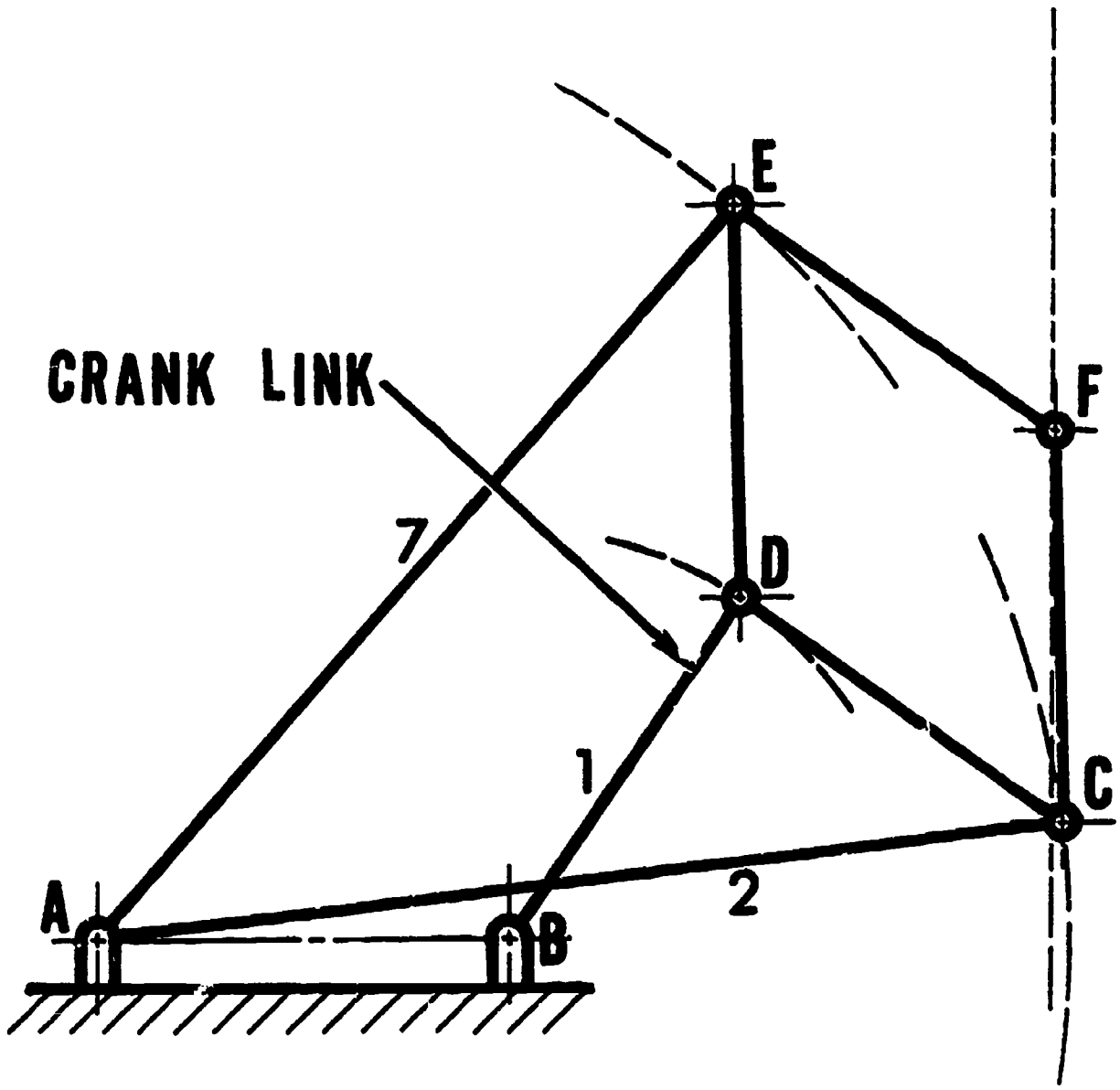


FRAME 6.6.

SIMPLE LINK 1 is called a CRANK LINK and introduces MOTION into the mechanism as it REVOLVES. The LINKAGE POINTS for each SIMPLE LINK in the mechanism move in curved or straight lines as link 1 revolves and as a result have LINEAR DISPLACEMENT.

LINKAGE POINTS __(a)__, __(b)__, __(c)__ and __(d)__ have LINEAR DISPLACEMENT, while the SIMPLE LINKS __(e)__, __(f)__ and __(g)__ have ANGULAR DISPLACEMENT.

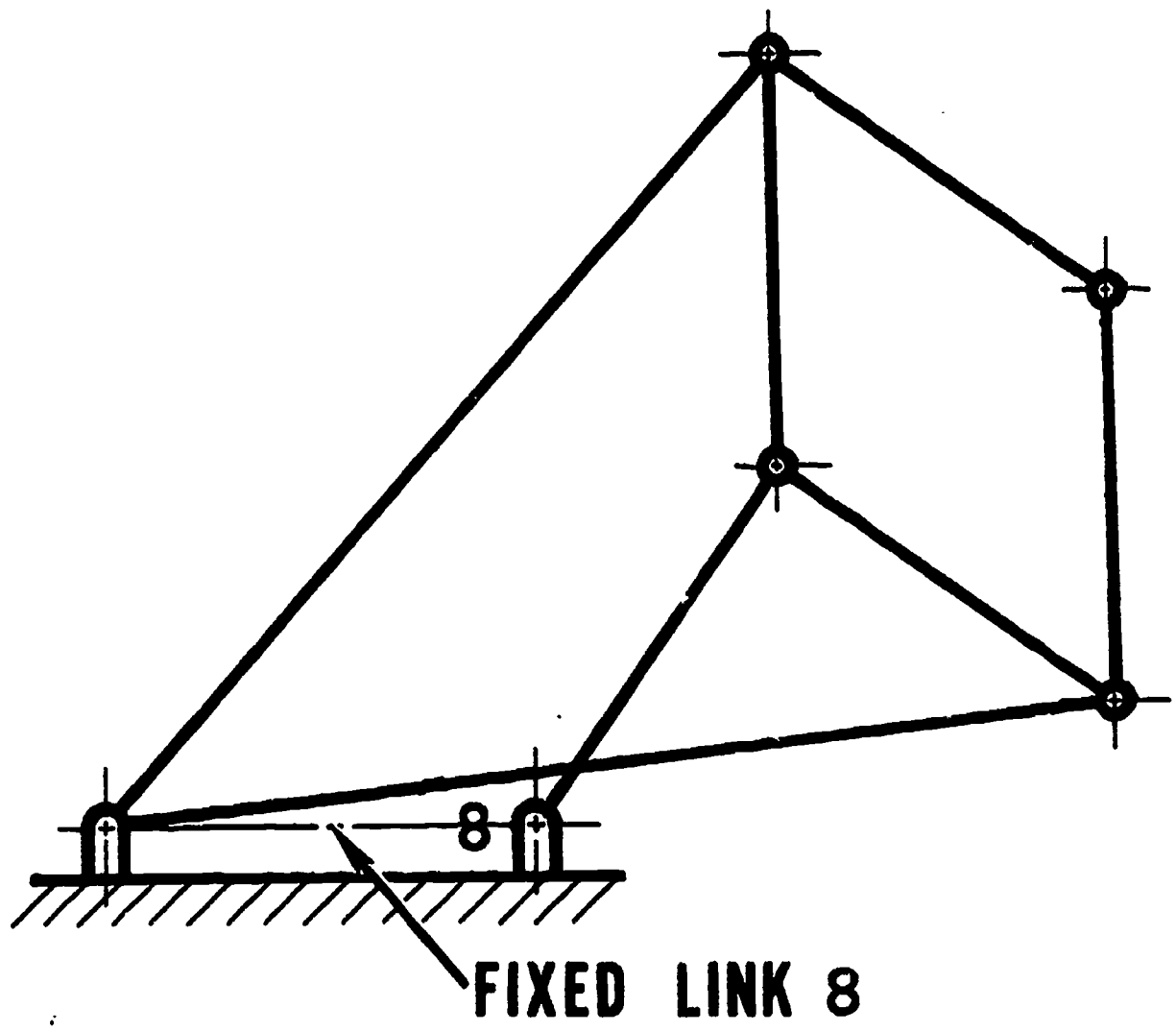
SIMPLE LINK 1 is called a __(h)__ LINK and introduces __(i)__ as it __(j)__.



FRAME 7.7.

The only SIMPLE LINK in PEAUCELLIER'S mechanism that does not move is link 8. This link is the FRAME fastened solidly to the GROUND and is called a FIXED LINK.

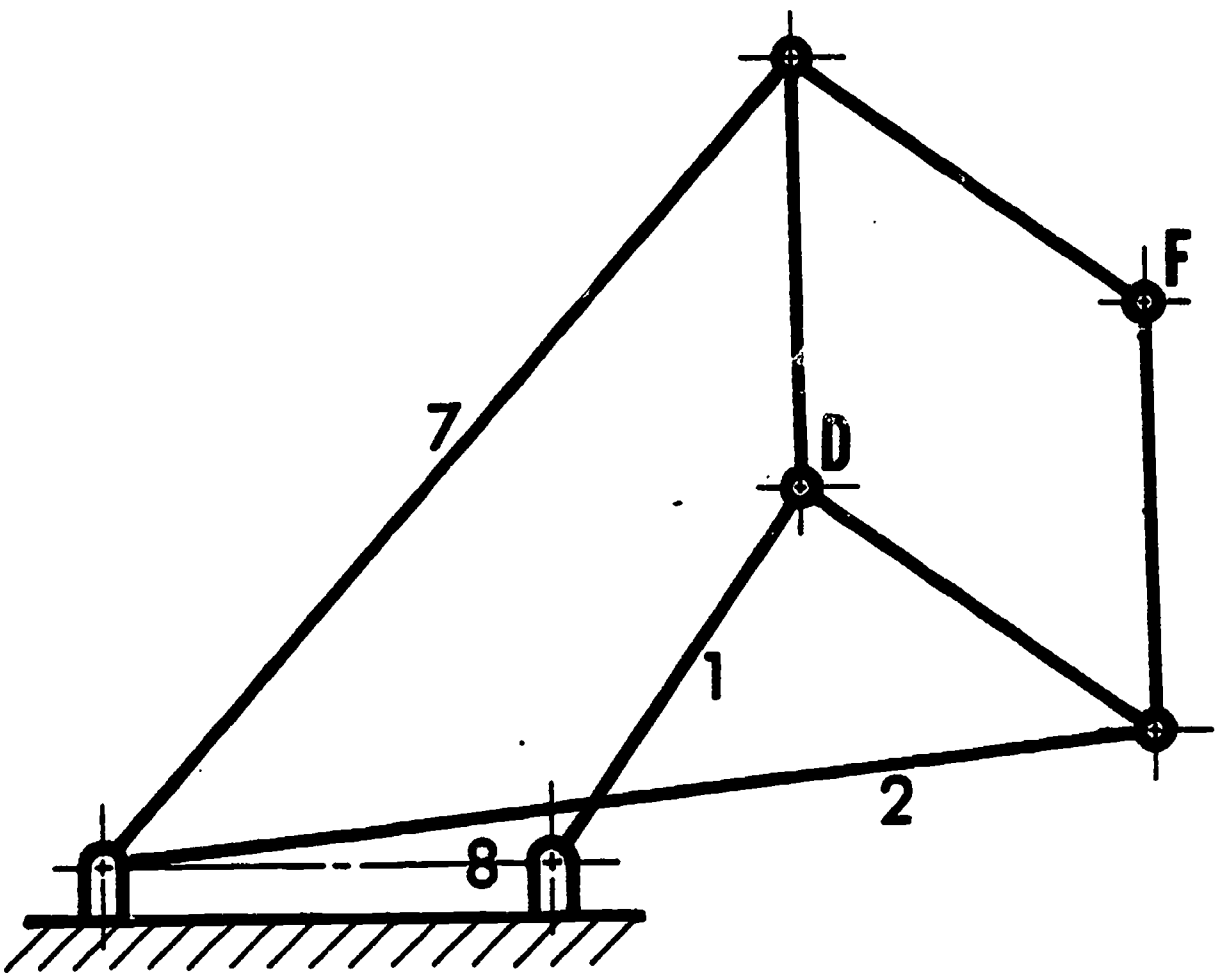
Link number (a) is classified as the FIXED LINK of the mechanism. It can be considered as the (b) of the mechanism.



FRAME 8.8.

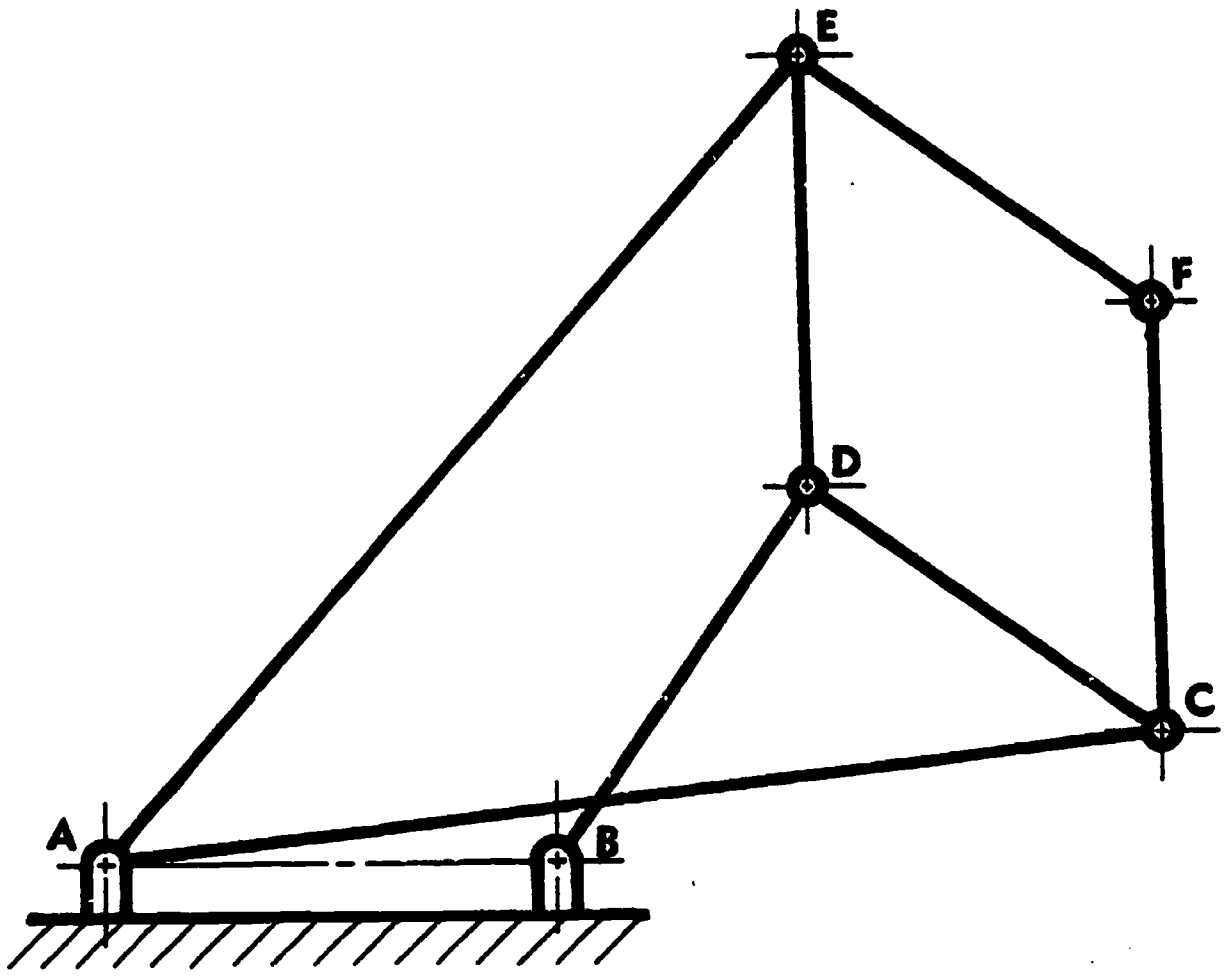
In PEAUCELLIER'S mechanism the SIMPLE LINKS and LINKAGE POINTS have various displacements consisting of ANGULAR and/or LINEAR displacements or motion. One FIXED LINK has NO displacement or motion.

Link 7 has __(a)__ motion.
Link 1 has __(b)__ motion.
LINKAGE POINT "F" has __(c)__ motion.
Link 8 has __(d)__ motion.
LINKAGE POINT "D" has __(e)__ motion.
Link 2 has __(f)__ motion.



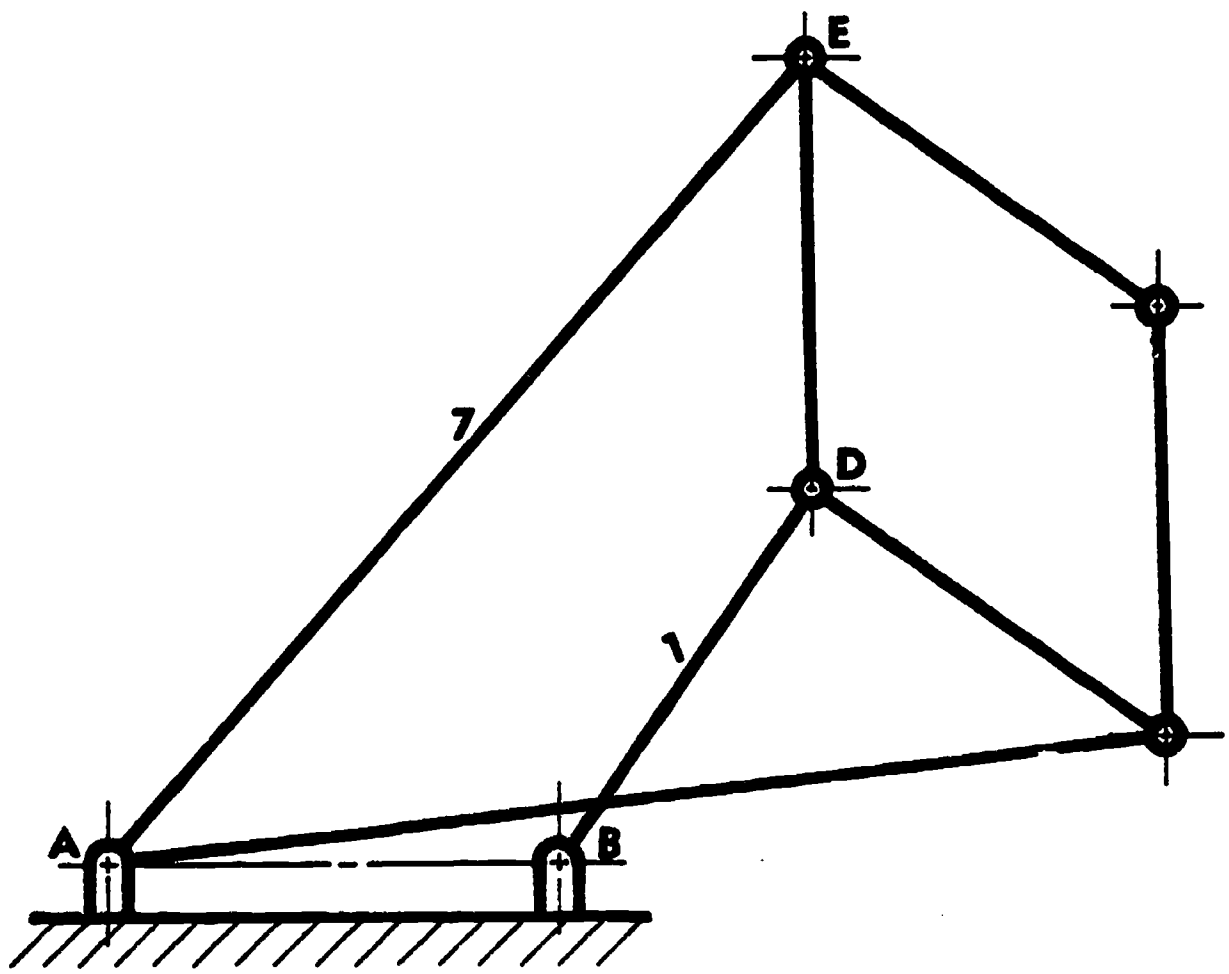
FRAME 8.8.1.

Points "F", __(a)__, __(b)__, and __(c)__ are classified as __(d)__ points.



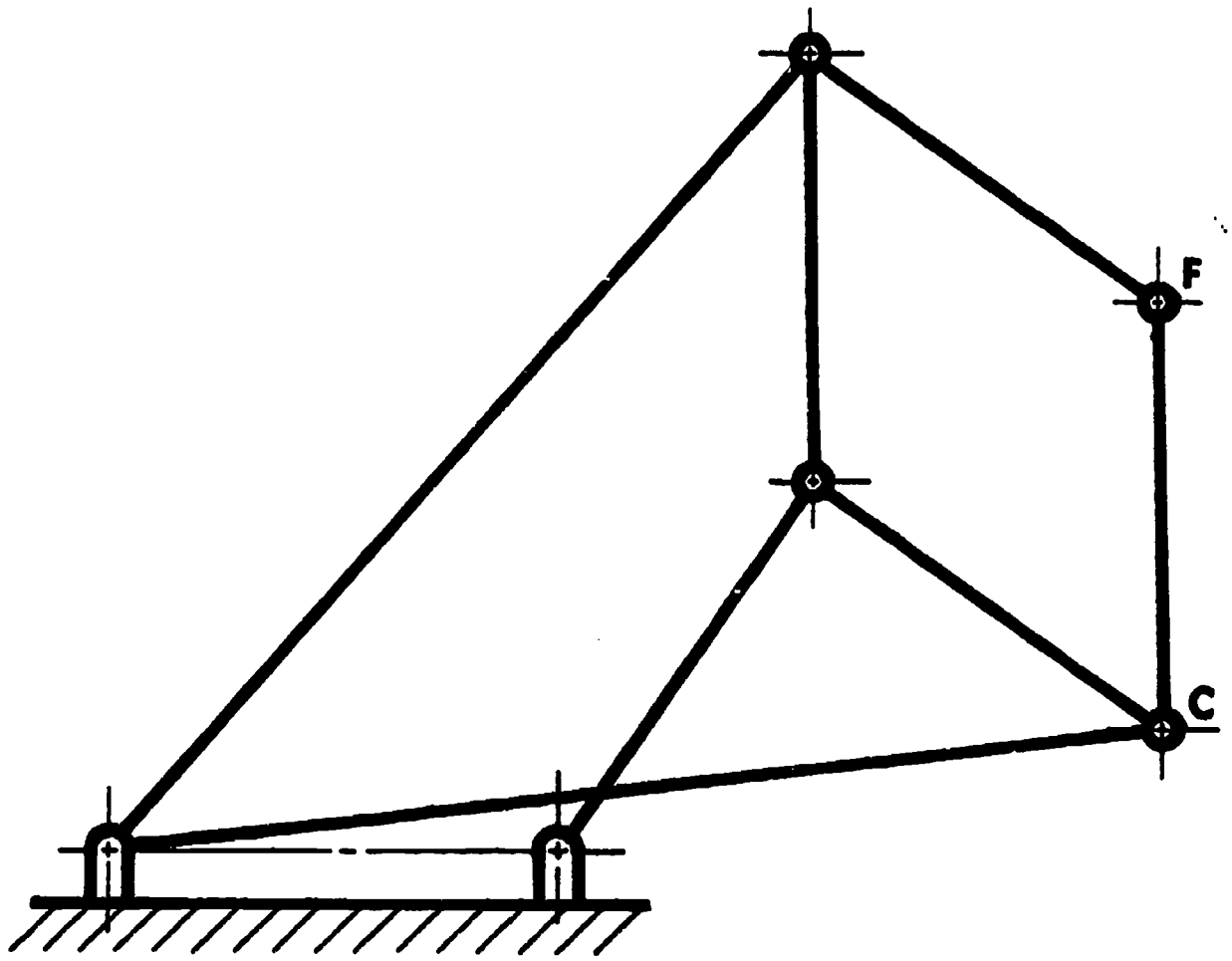
FRAME 8.8.2.

Lines 1 ($\overline{BD}$) and 7 ($\overline{AE}$) have ___(a)___ displacement.

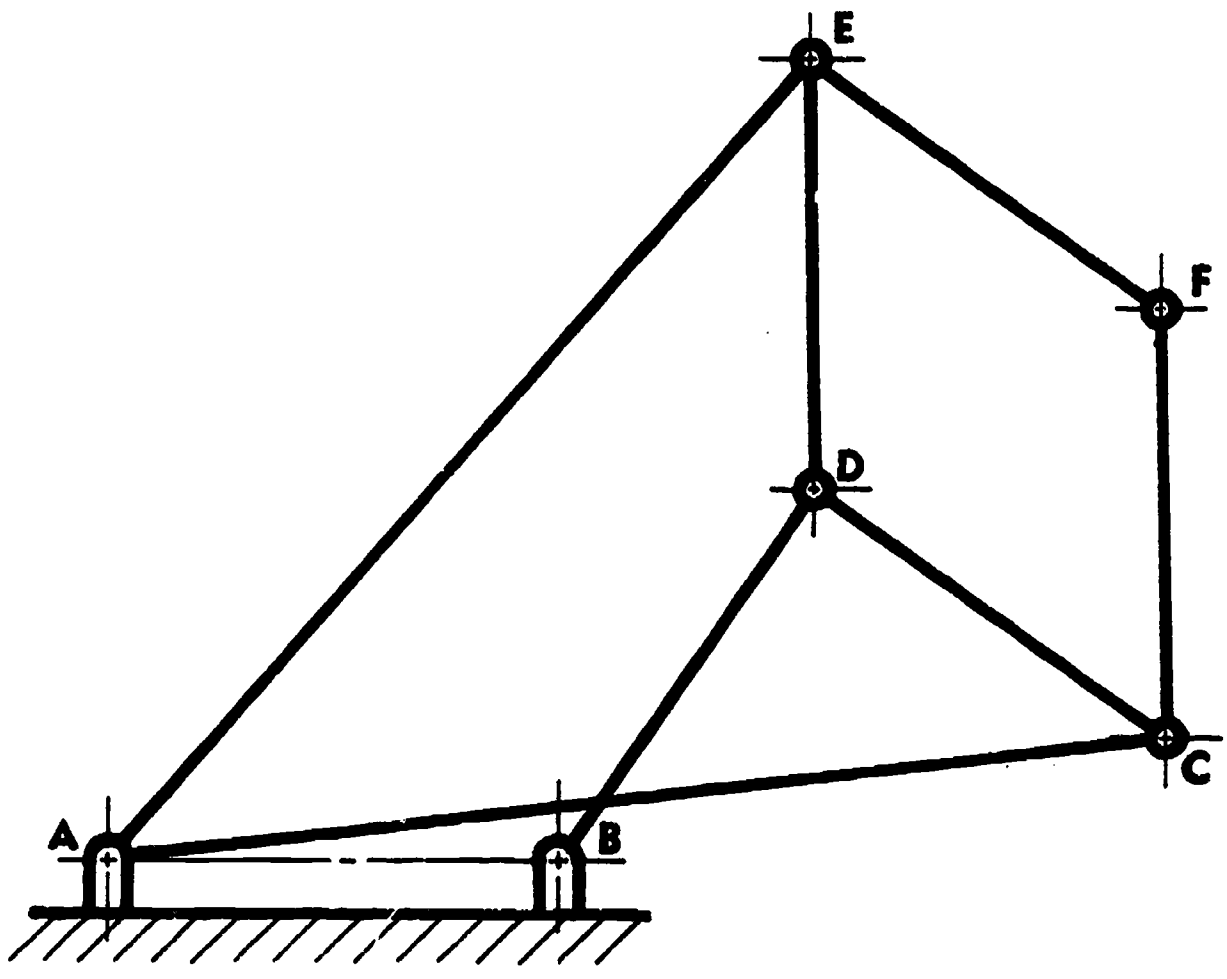


FRAME 8.8.3.

Points "F" and "C" have ___(a)___ displacement.

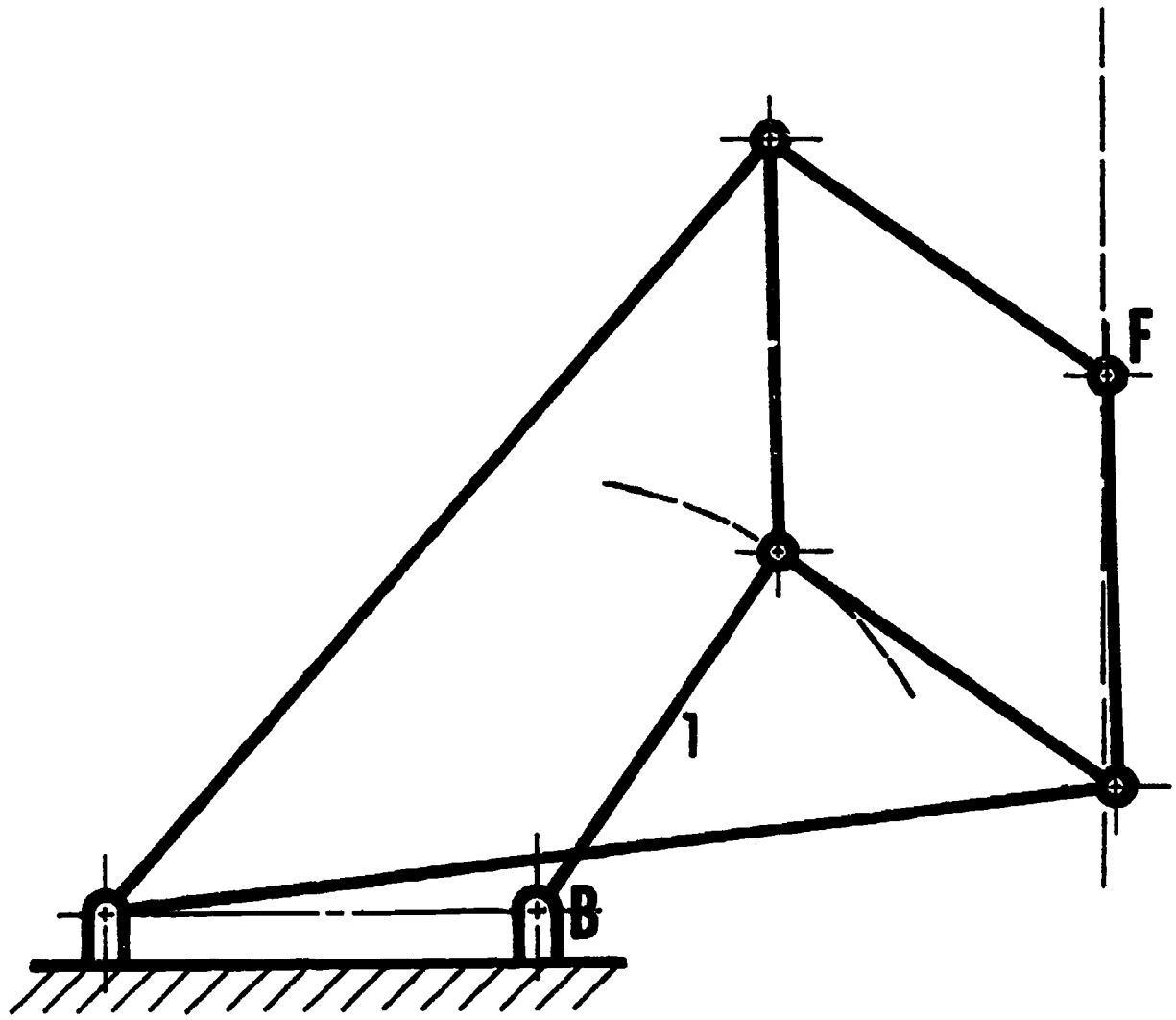


Points ___(a)___ and ___(b)___ are classified as PIVOT POINTS.



The UNMODIFIED PEAUCELLIER'S STRAIGHT-LINE mechanism you have been studying is a mechanism which moves LINKAGE POINT "F" in a straight line as CRANK LINK 1 rotates about PIVOT POINT "B".

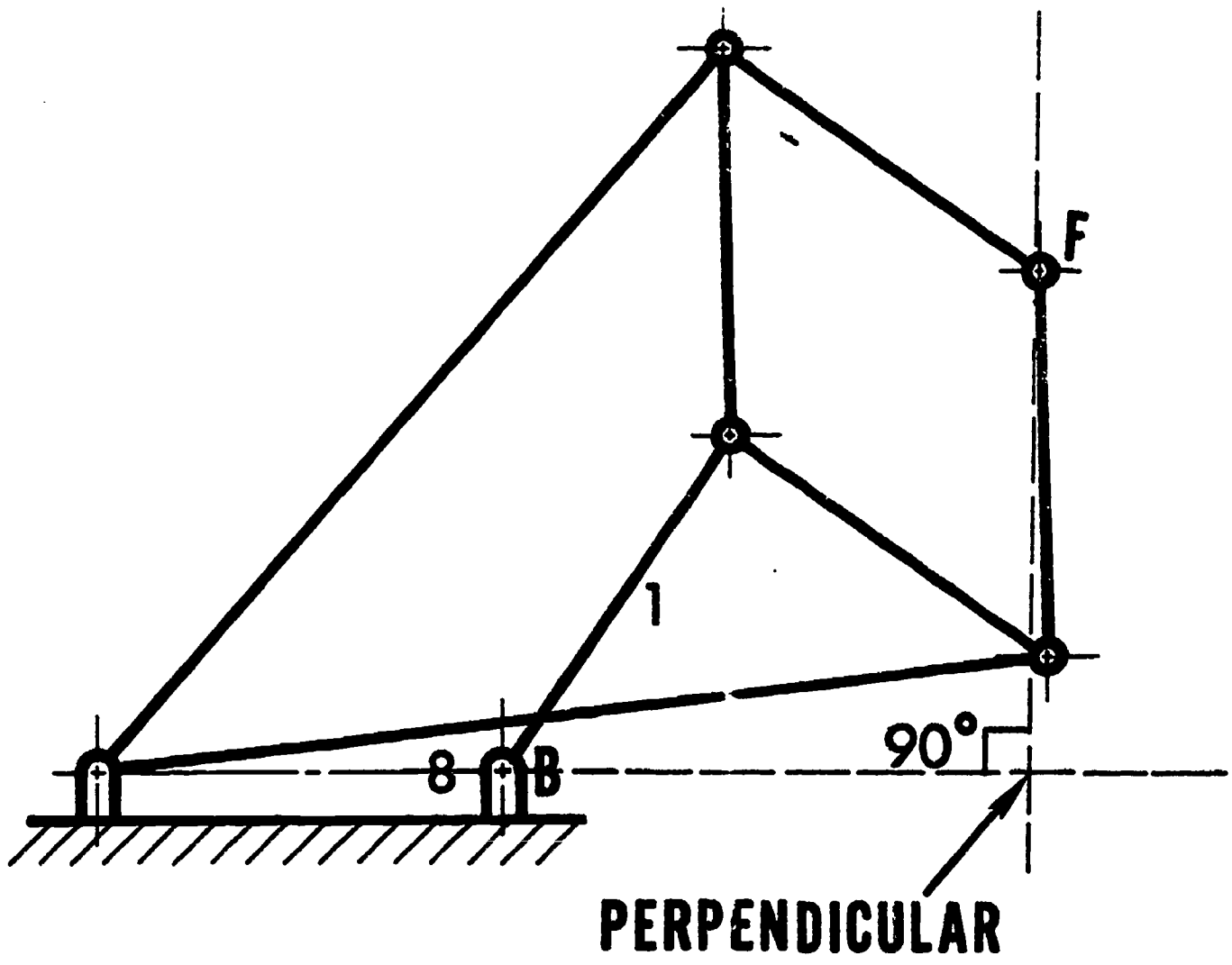
An __(a)__ PEAUCELLIER'S STRAIGHT-LINE linkage will move LINKAGE POINT __(b)__ in a straight line path as __(c)__ LINK __(d)__ revolves.



FRAME 10.10.

In an UNMODIFIED PEAUCELLIER'S mechanism LINKAGE POINT "F" will always move in a straight line PERPENDICULAR to FIXED LINK 8 extended as shown in the illustration.

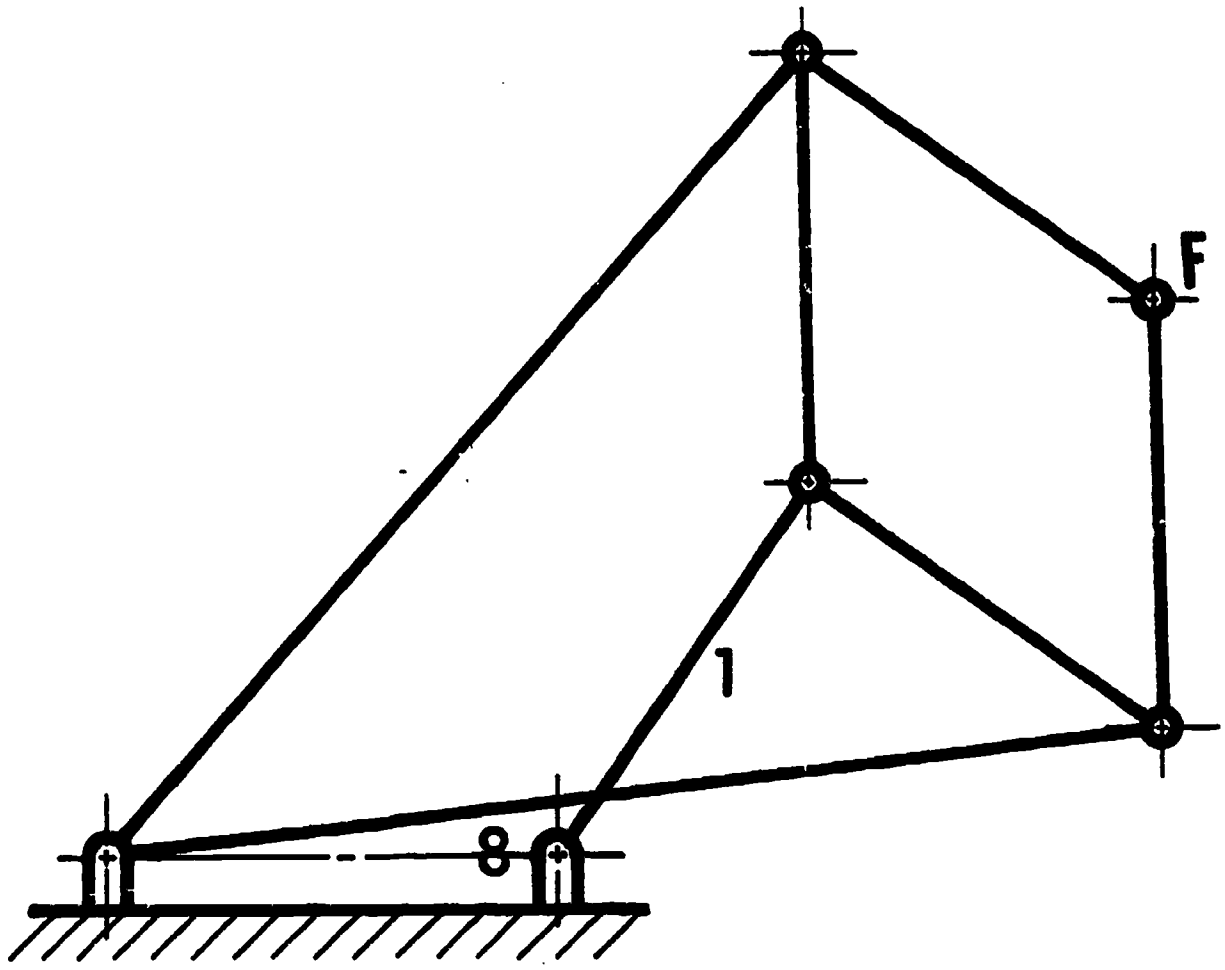
As CRANK LINK 1 revolves about (a) point "B", in an UNMODIFIED PEAUCELLIER'S mechanism, LINKAGE POINT (b) will always move in a straight line that is (c) to link 8 extended.



FRAME 11.11.

In order to make LINKAGE POINT "F" move in a straight line path the designer must make links 8 and 1 equal in length in the UNMODIFIED PEAUCELLIER'S mechanism.

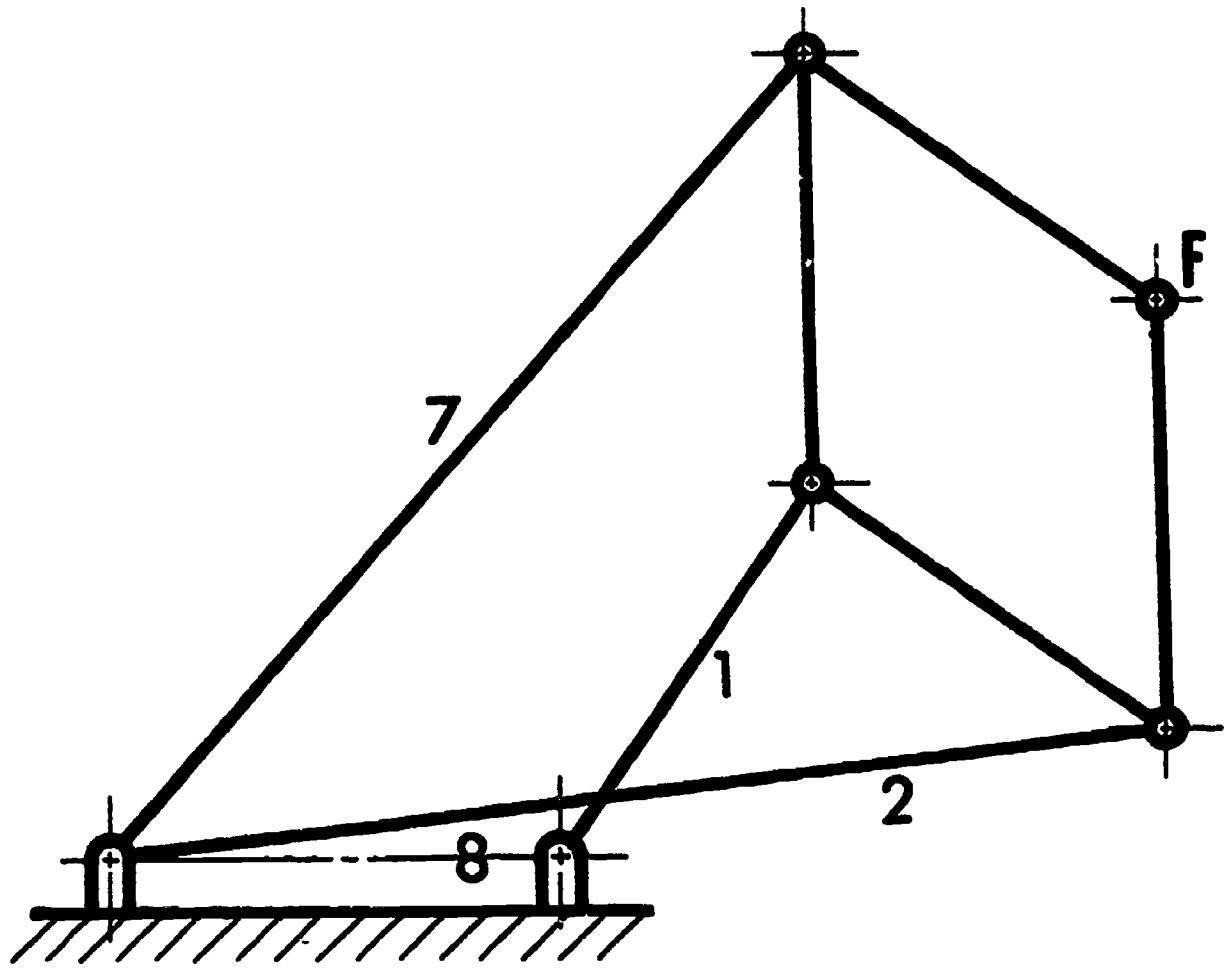
As link 1 revolves, LINKAGE POINT "F" will make a straight line path only if links <u>(a)</u> and <u>(b)</u> are equal.



FRAME 12.12.

In order to make LINKAGE POINT "F" move in a straight line the designer must make links 7 and 2 equal in length. They cannot equal links 1 and 8 in length.

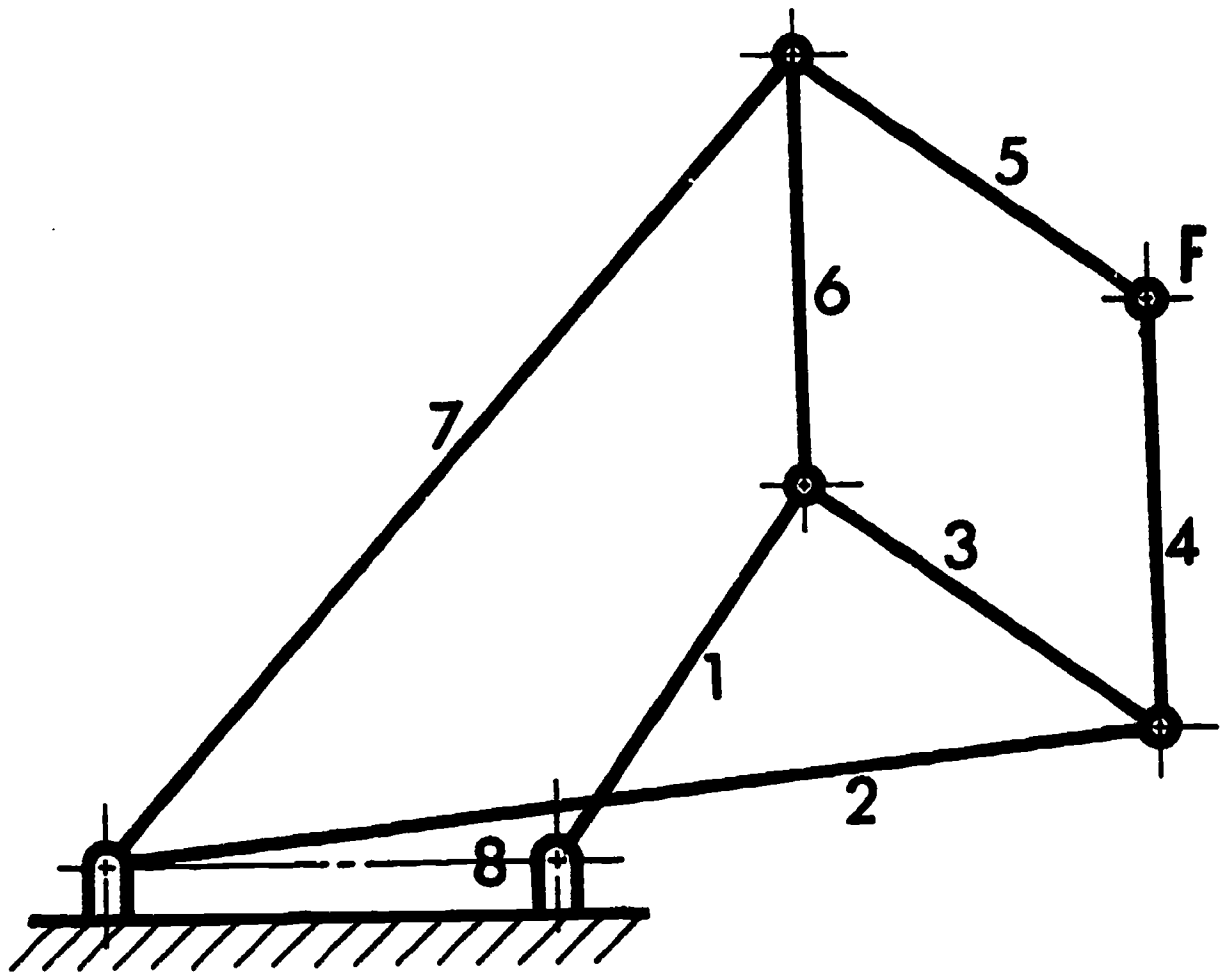
Point "F" will move in a straight line only if links 7 and __(a)__ are equal in length. Links 8 and __(b)__ must be equal in length, but cannot be the same length as links __(c)__ and 7.



FRAME 13.13.

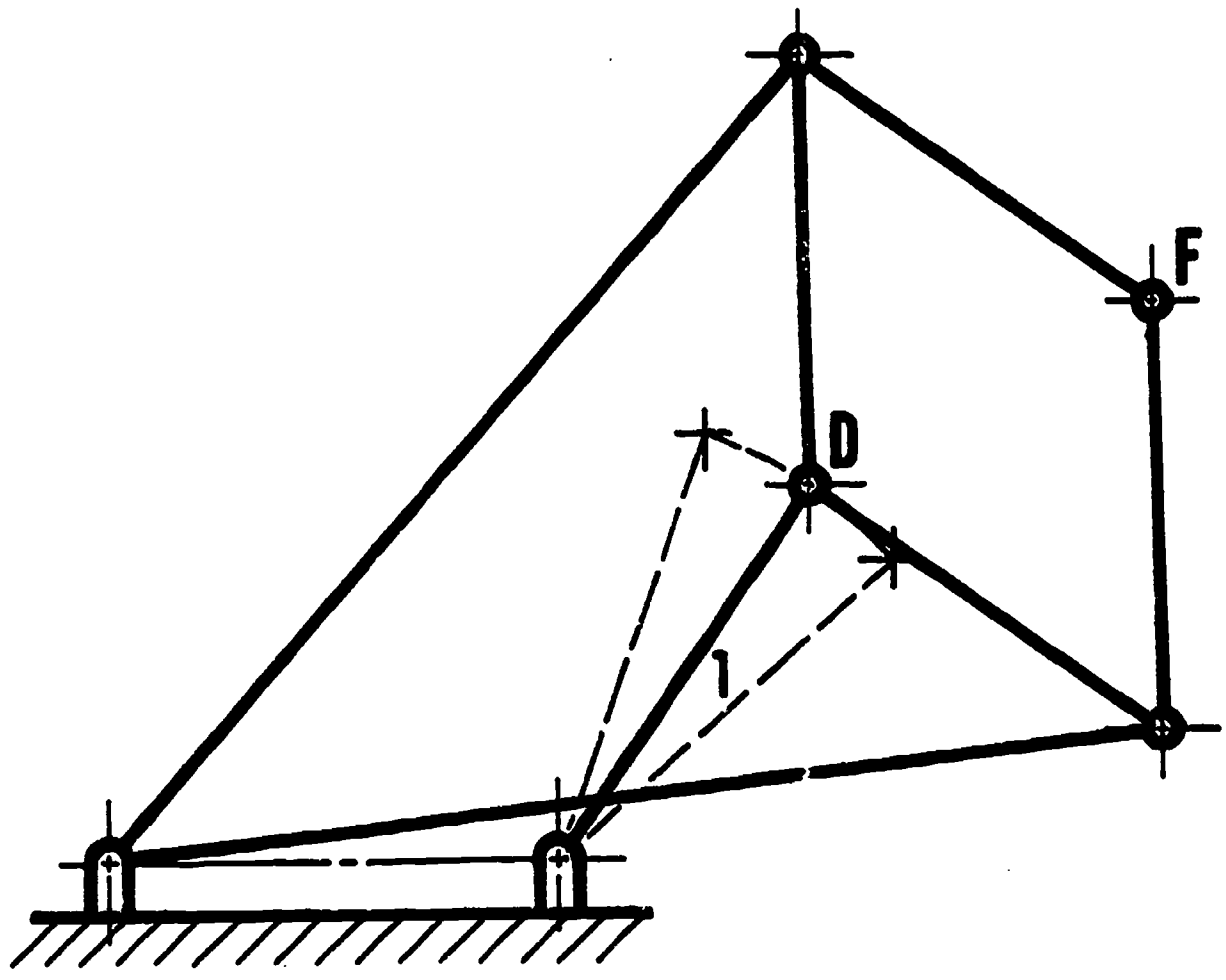
The designer must make links 3, 6, 5 and 4 equal in length in order for LINKAGE POINT "F" to move in a straight line path.

In order for LINKAGE POINT "F" to move in a straight line the designer must make links 1 and (a) equal. He must make links 3, (b), (c) and (d) equal and make links 2 and (e) equal to each other in length.



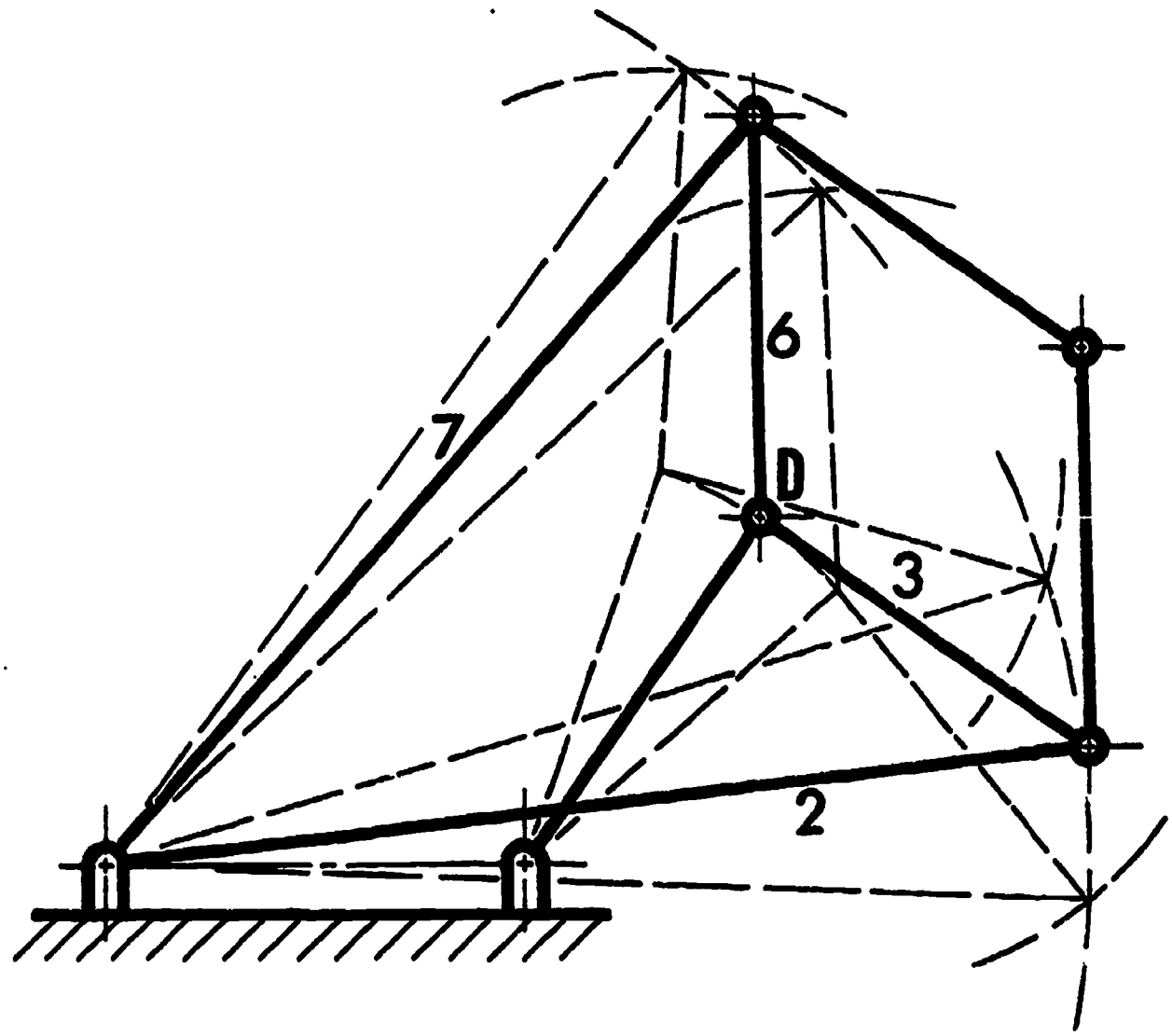
The following six steps and illustrations show the procedure for determining the path of point "F" for given positions of CRANK LINK 1.

1. Revolve CRANK LINK 1 clockwise and counter-clockwise 15 degrees.
2. Locate the two new positions of LINKAGE POINT "D"



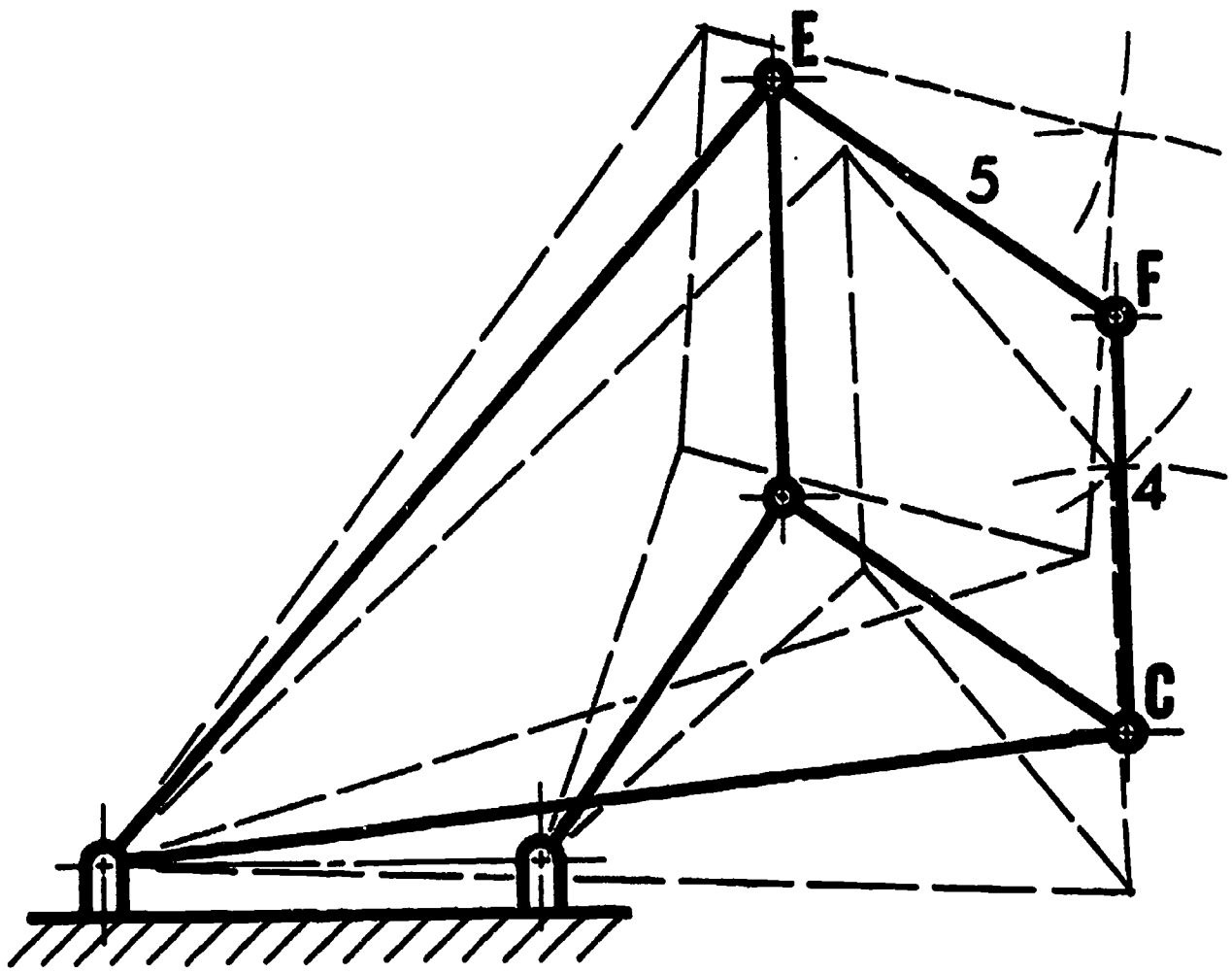
PROCEED TO NEXT FRAME

3. From each of the two new positions of linkage point "D" draw a radius equal in length equal to links 3 and 6.
4. Revolve links 2 and 7 by drawing an arc radius equal in length to links 2 and 7.



PROCEED TO
NEXT FRAME

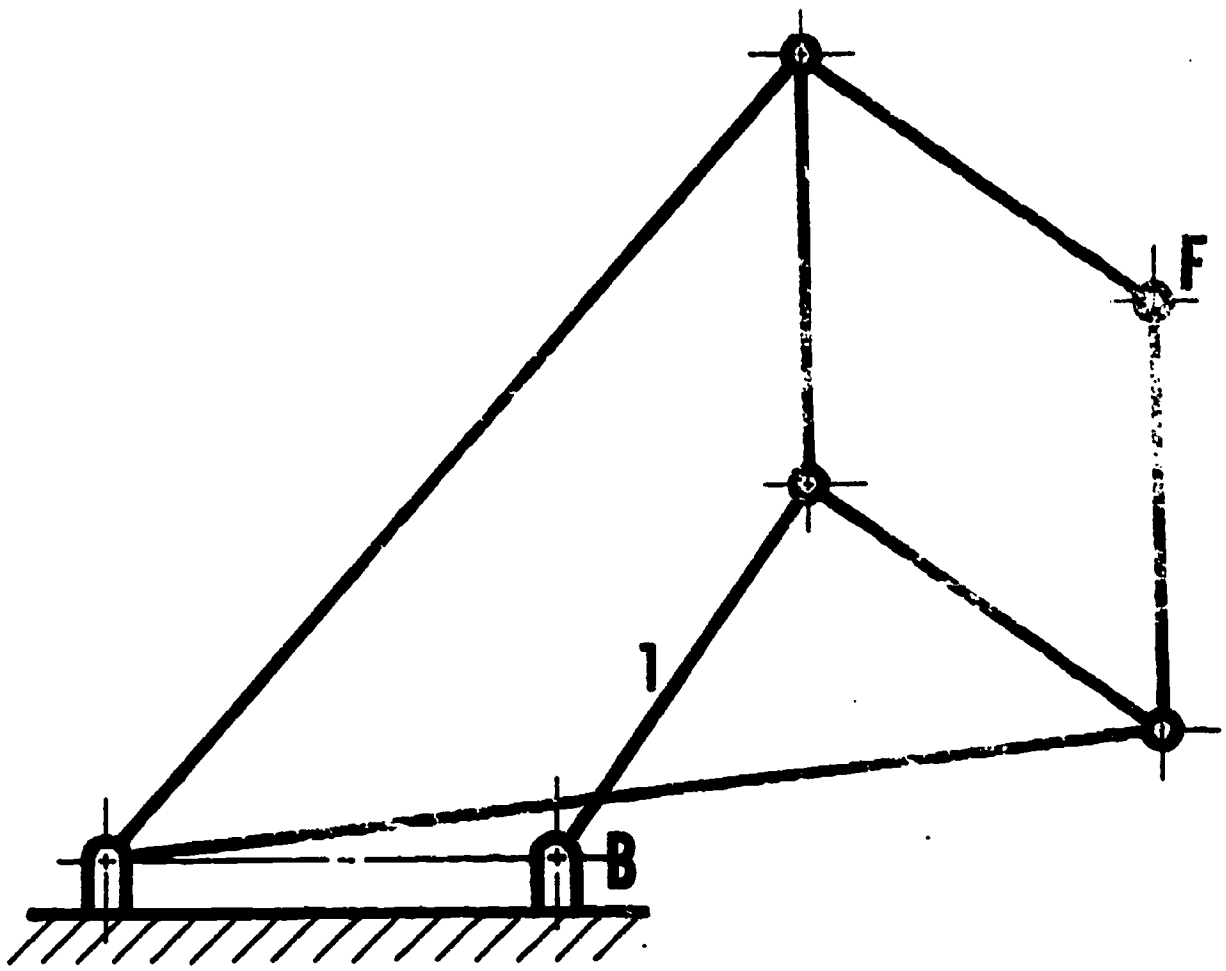
5. Where the arc radius from "Step 4." intersects the two circles developed in "Step 3." the new positions for LINKAGE POINTS "E" and "C" are formed.
6. From the new positions of "E" and "C" draw two radius arcs equal to links 4 and 5. Where these two arcs cross point "F" is located.



PROCEED TO
NEXT FRAME

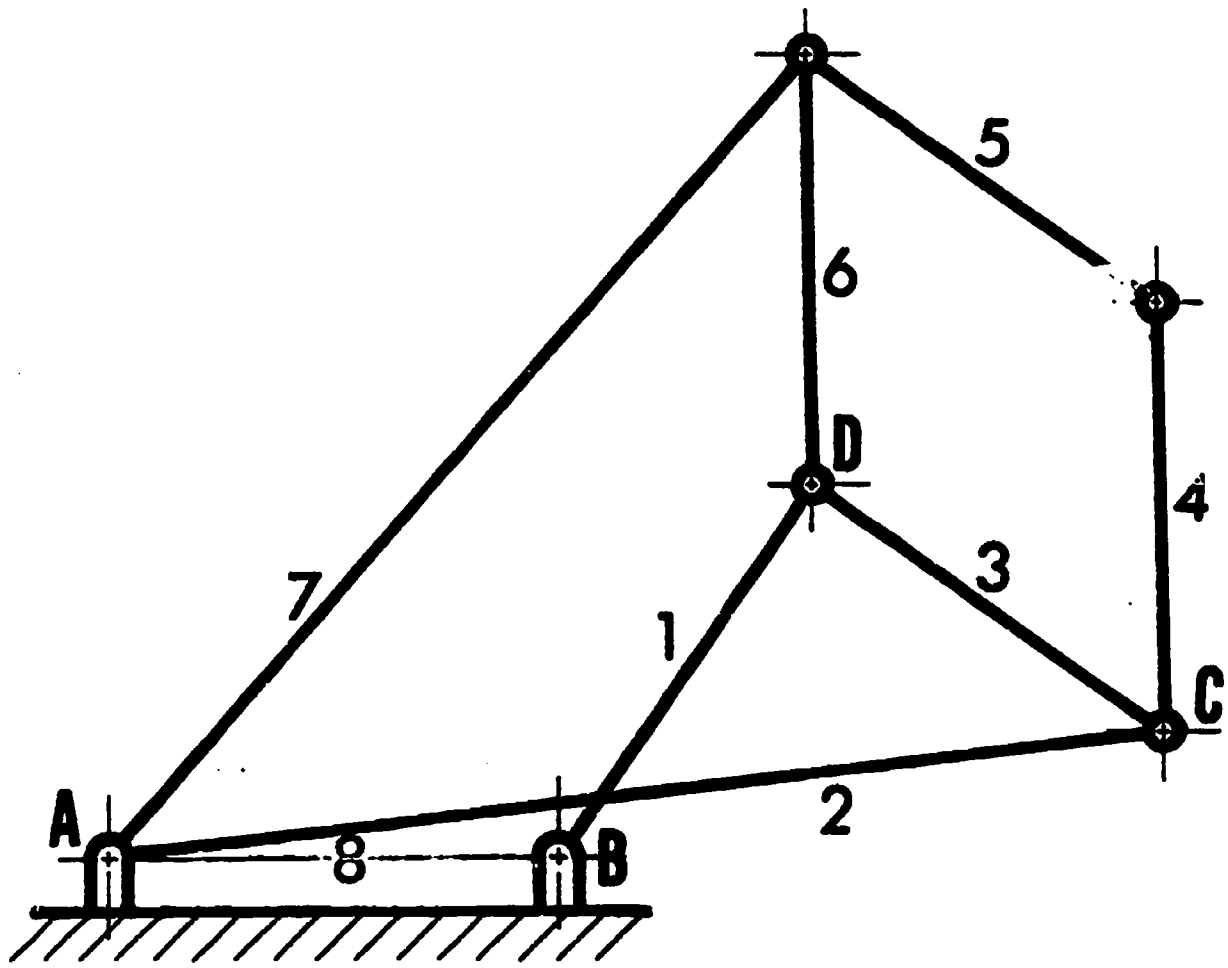
FRAME 13.16.1.

As line number ___(a)___ revolves about point "B", point "F" will make a ___(b)___ line path.



FRAME 13.16.2.

In order to make point "F" move in a straight line path the designer must make lines 3 ($\overline{CD}$), __(a)__, __(b)__ and __(c)__ equal.

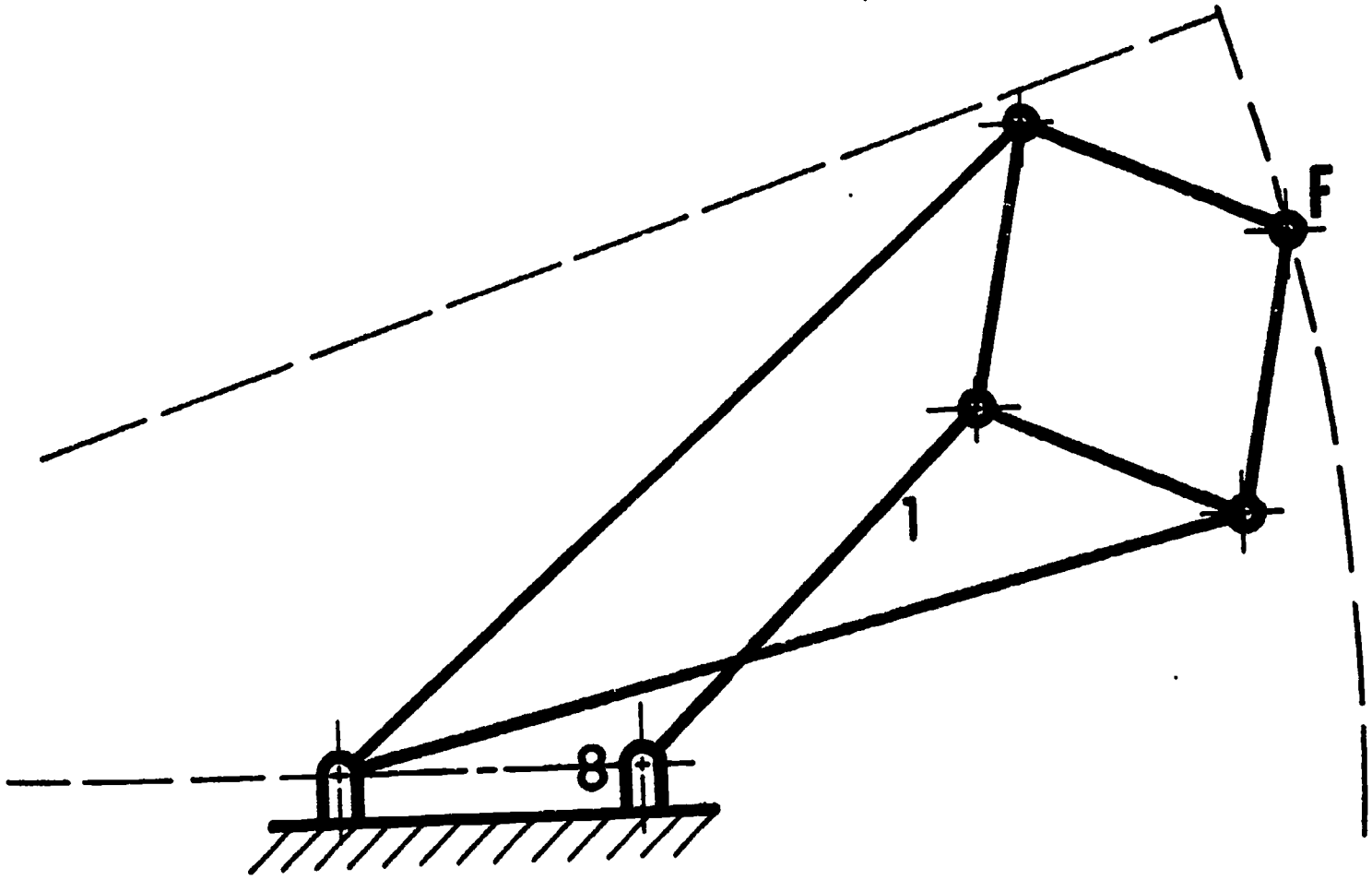


The second KINEMATIC form you are going to study is a MODIFIED PEAUCELLIER'S mechanism. A MODIFIED PEAUCELLIER'S mechanism is different from an UNMODIFIED PEAUCELLIER'S mechanism. A MODIFIED PEAUCELLIER'S mechanism is a mechanism in which link 8 is not EQUAL to link 1 in length and causes LINKAGE POINT "F" to follow a CURVED arc of a circle instead of a straight line. The other link lengths will remain the same as in an UNMODIFIED PEAUCELLIER'S mechanism.

Point "F" moves in a __(a)__ arc in a MODIFIED PEAUCELLIER'S LINKAGE.

Link 8 and link __(b)__ must not be __(c)__ in length in a __(d)__ PEAUCELLIER'S mechanism.

Link 1 and link __(e)__ must be __(f)__ in length in an UNMODIFIED PEAUCELLIER'S mechanism.

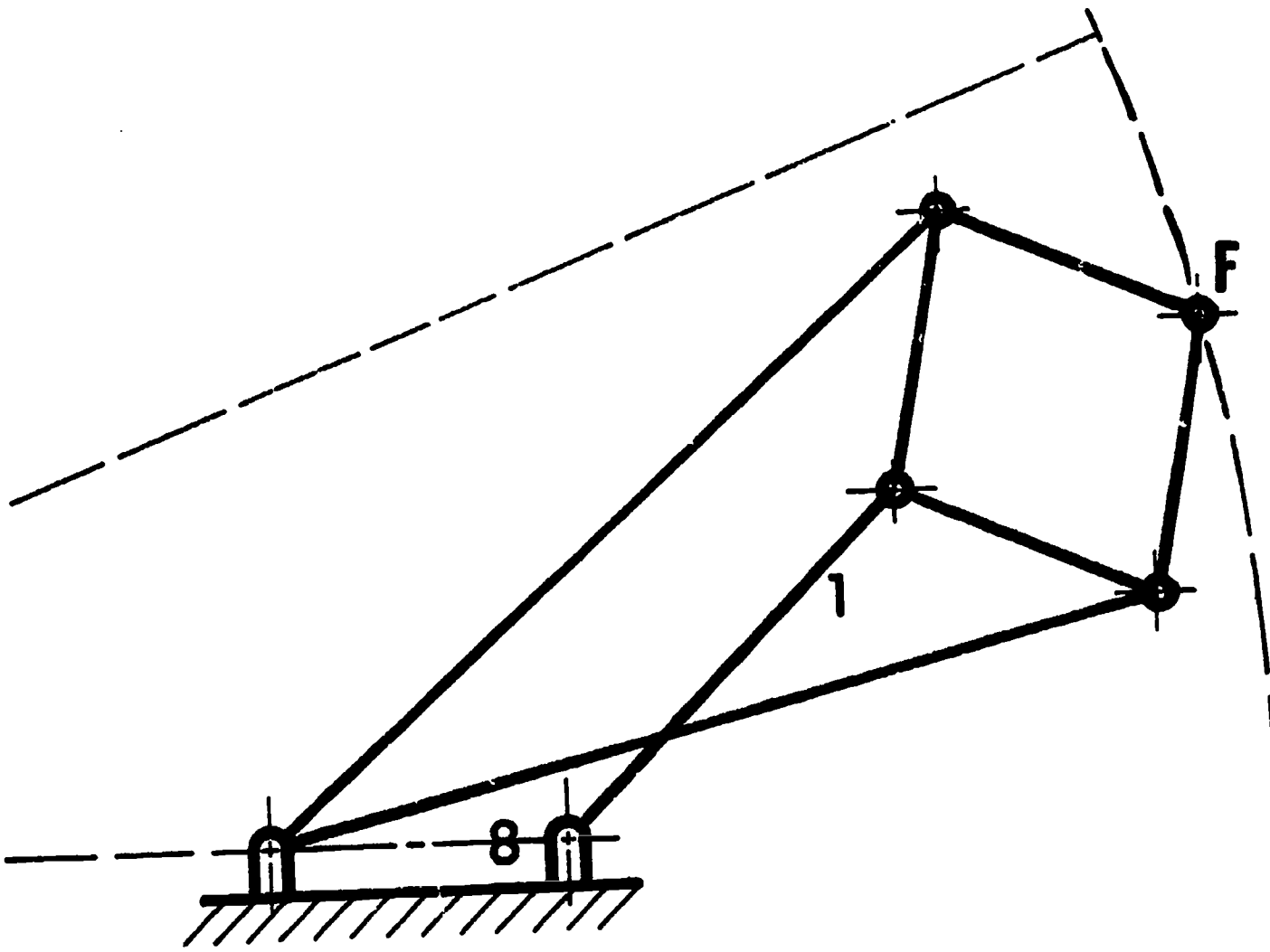


FRAME 16.18.

In a MODIFIED PEAUCELLIER'S mechanism, if link 1 is greater in length than link 8, the center of the radius of the arc that linkage point "F" makes is to the LEFT as shown in the illustration. The center of the radius falls on link 8 extended to the left.

In a MODIFIED PEAUCELLIER'S mechanism with link 8 less than link 1, LINKAGE POINT "F" will make a curved path that has the center of its radius to the (a) .

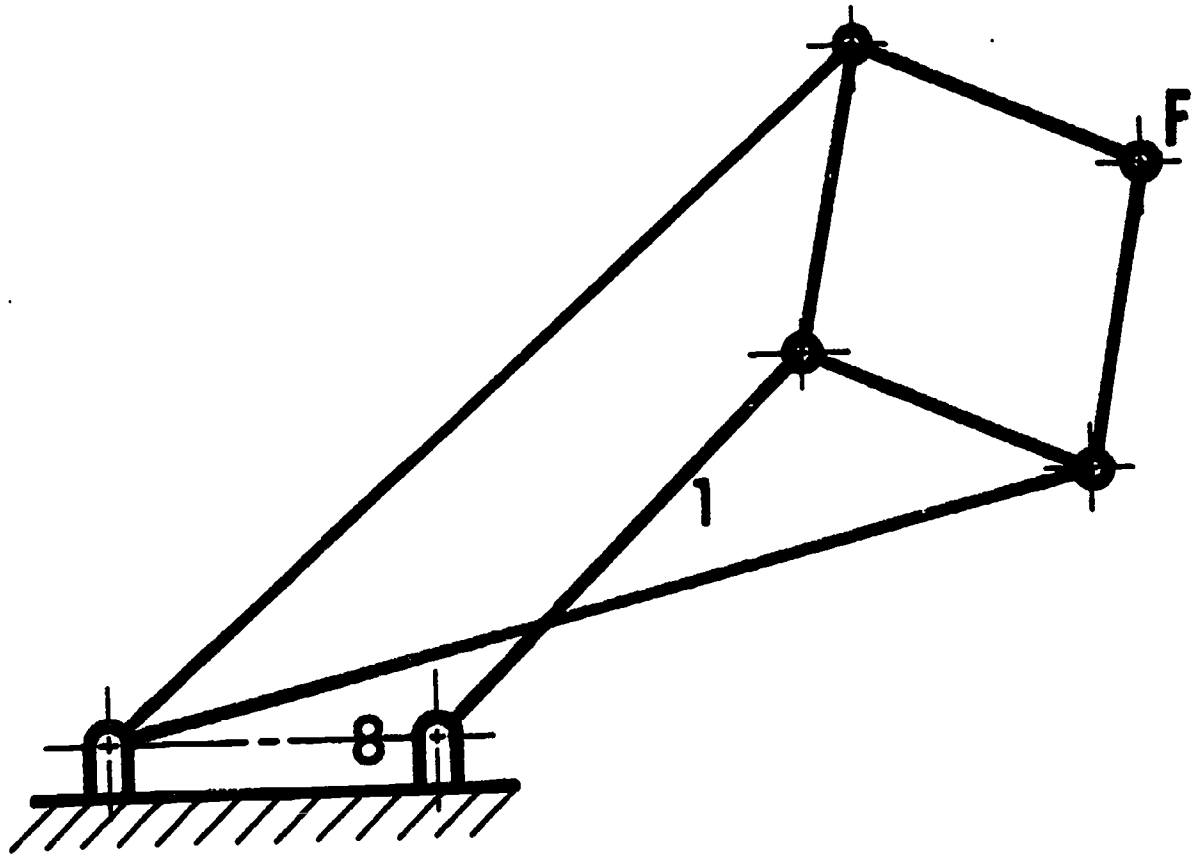
The center of the radius will fall on link (b) extended.



FRAME 17.19.

If link 1 is made less in length than link 8, the center of the radius is to the RIGHT, on link 8 extended. All other link lengths in the MODIFIED PEAUCELLIER'S mechanism will remain the same as in an UNMODIFIED PEAUCELLIER'S mechanism.

If link 8 is greater than link 1, LINKAGE POINT "F" will make a curved path with its radius to the __(a)__, with its center on __(b)__ extended.

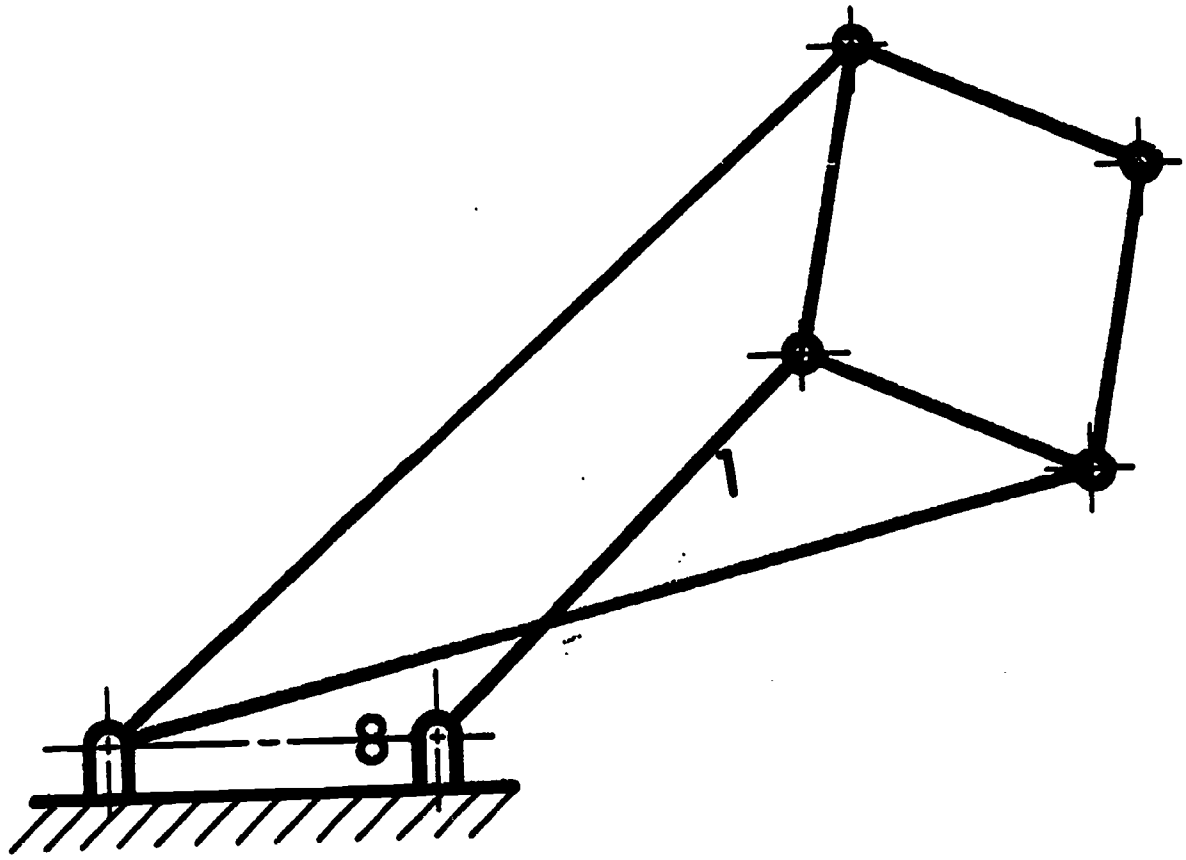


FRAME 18.20.

The illustration shows a MODIFIED PEAUCELLIER'S mechanism.

In order to make the mechanism illustrated, an UNMODIFIED PEAUCELLIER'S mechanism, the designer should make link 1 equal in length to link __(a)__.

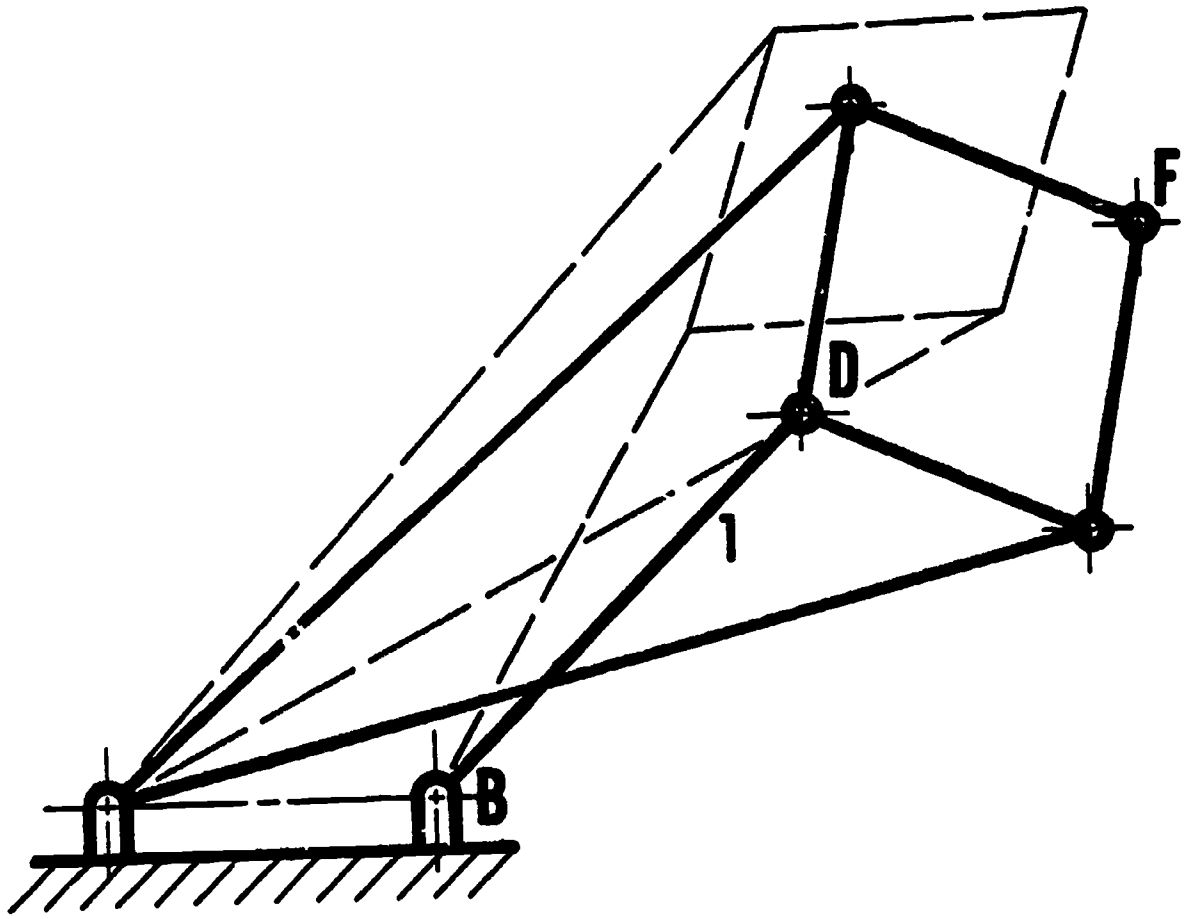
All other links in both the UNMODIFIED and MODIFIED PEAUCELLIER'S mechanism will __(b)__ each other in length.



FRAME 19.21.

In the illustration of a MODIFIED PEAUCELLIER'S mechanism as link 1 revolves 15 degrees counter-clockwise about PIVOT POINT "B", from the original position, points "D" and "F" move APART. The same is true in an UNMODIFIED PEAUCELLIER'S mechanism.

As link 1 revolves counter-clockwise points "D" and "F" move <u>(a)</u> in an UNMODIFIED and a <u>(b)</u> <u>(c)</u> mechanism.

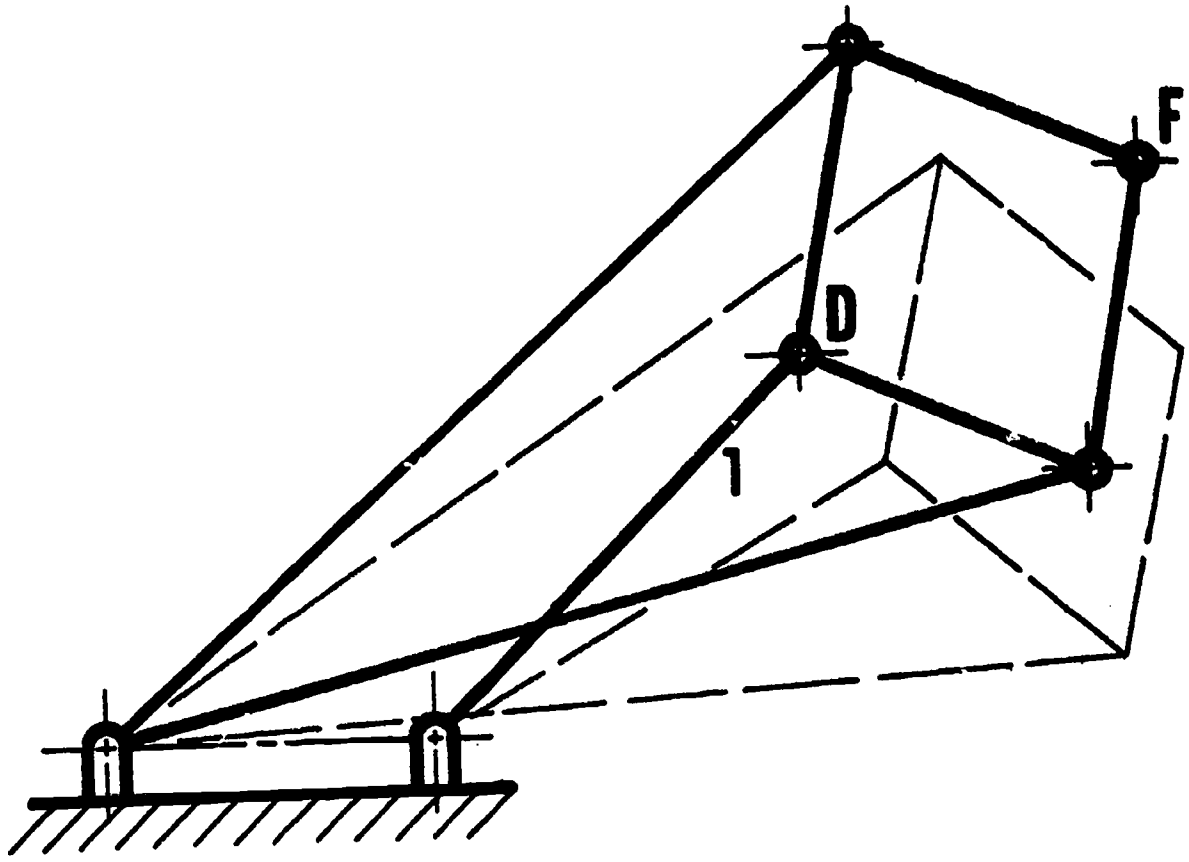


FRAME 20.22.

As link number 1 revolves clockwise, points "D" and "F" move CLOSER TOGETHER in an UNMODIFIED and MODIFIED PEAUCELLIER'S mechanism.

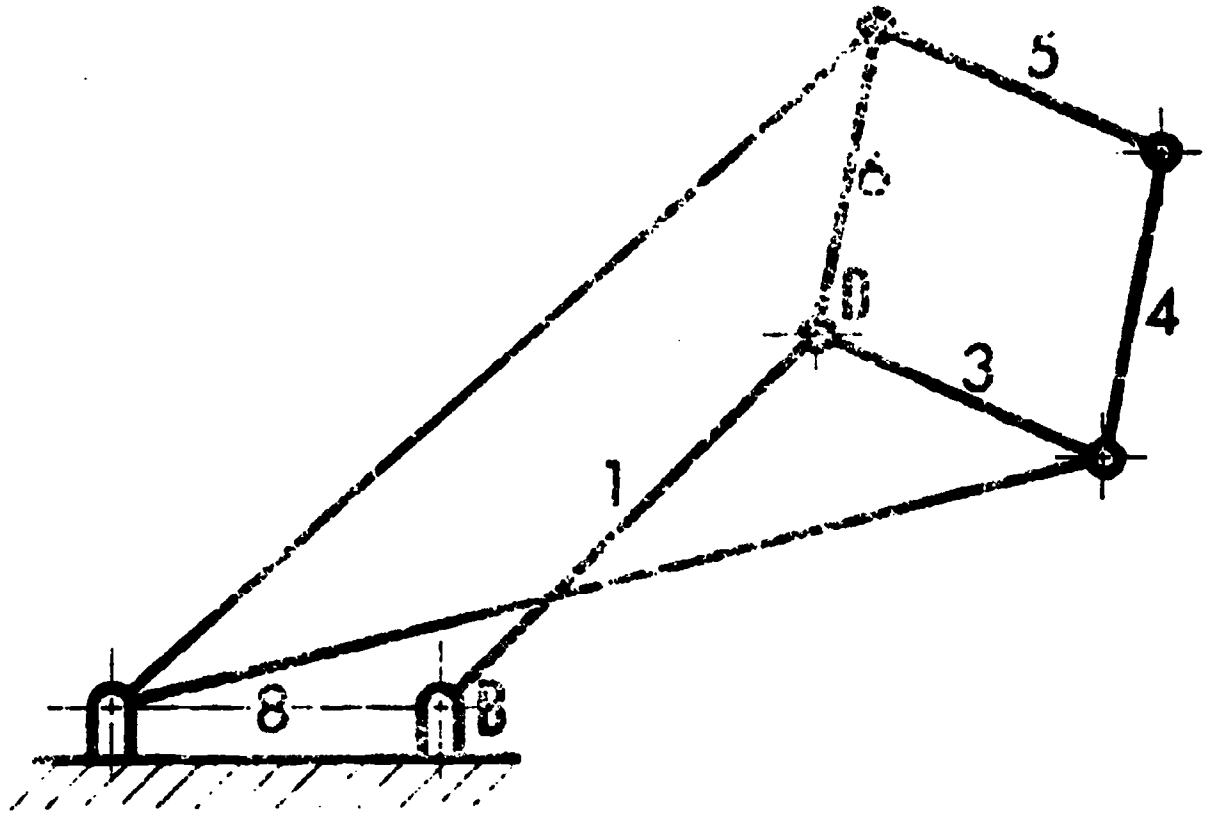
Points "D" and "F" move _(a)_ _(b)_ as 1 revolves clockwise.

Points "D" and "F" move _(c)_ as 1 revolves counterclockwise.



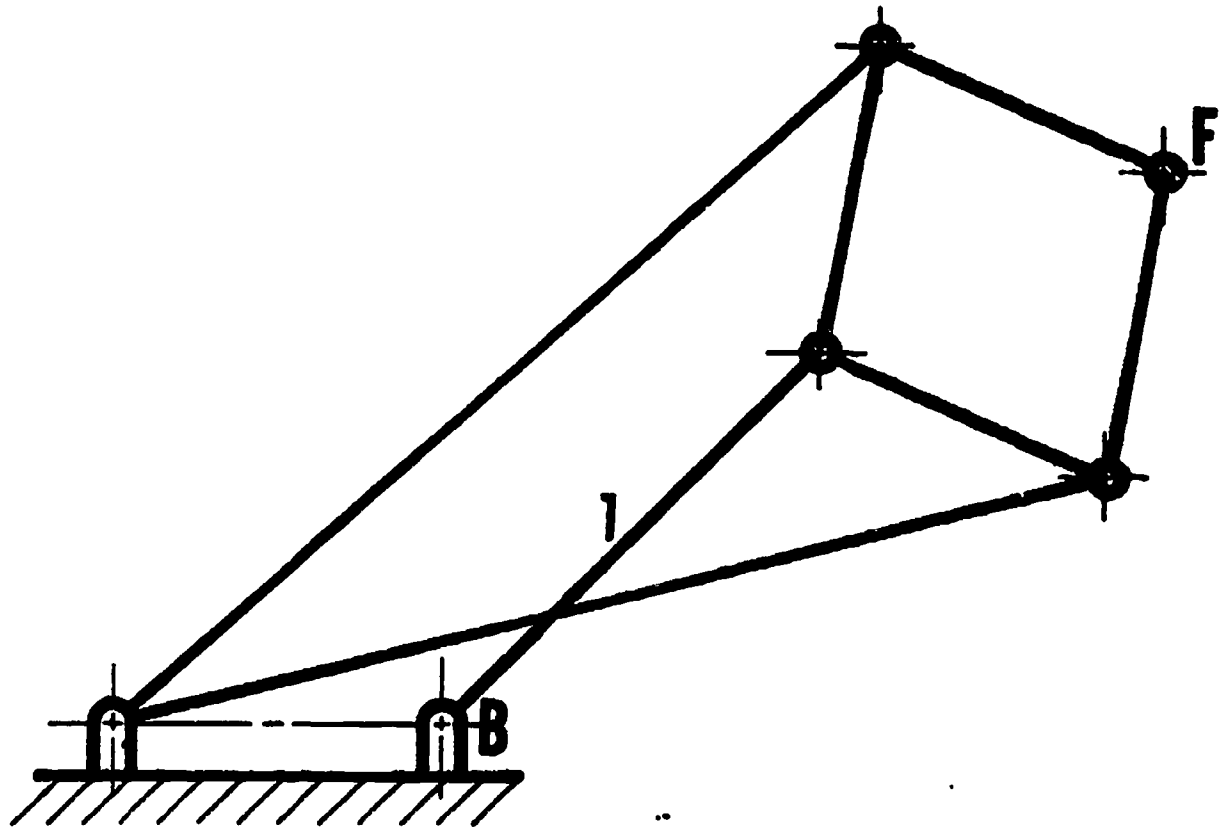
FRAME 20.22.1.

In order to make the mechanism an UNMODIFIED MECHANISM the designer should make line number 1 (BD) equal to line number ___(a)___.

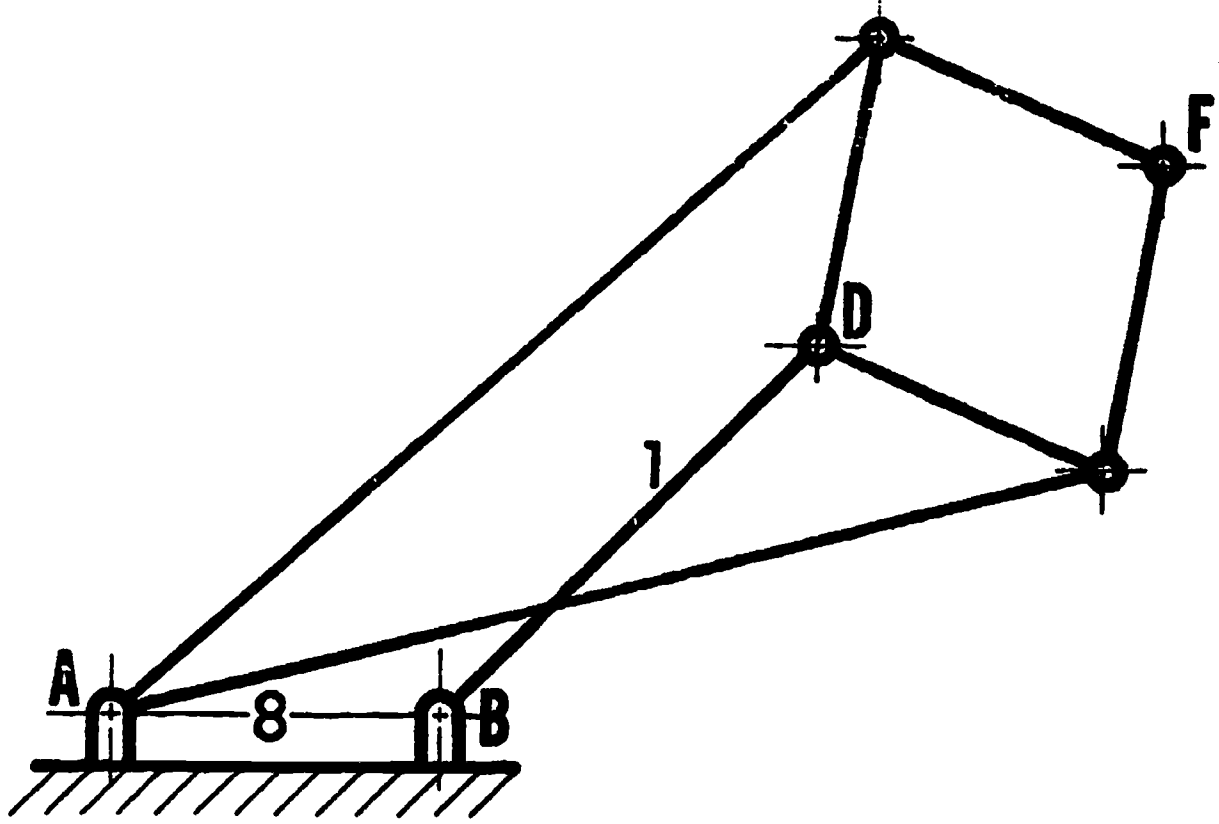


FRAME .20.22.2.

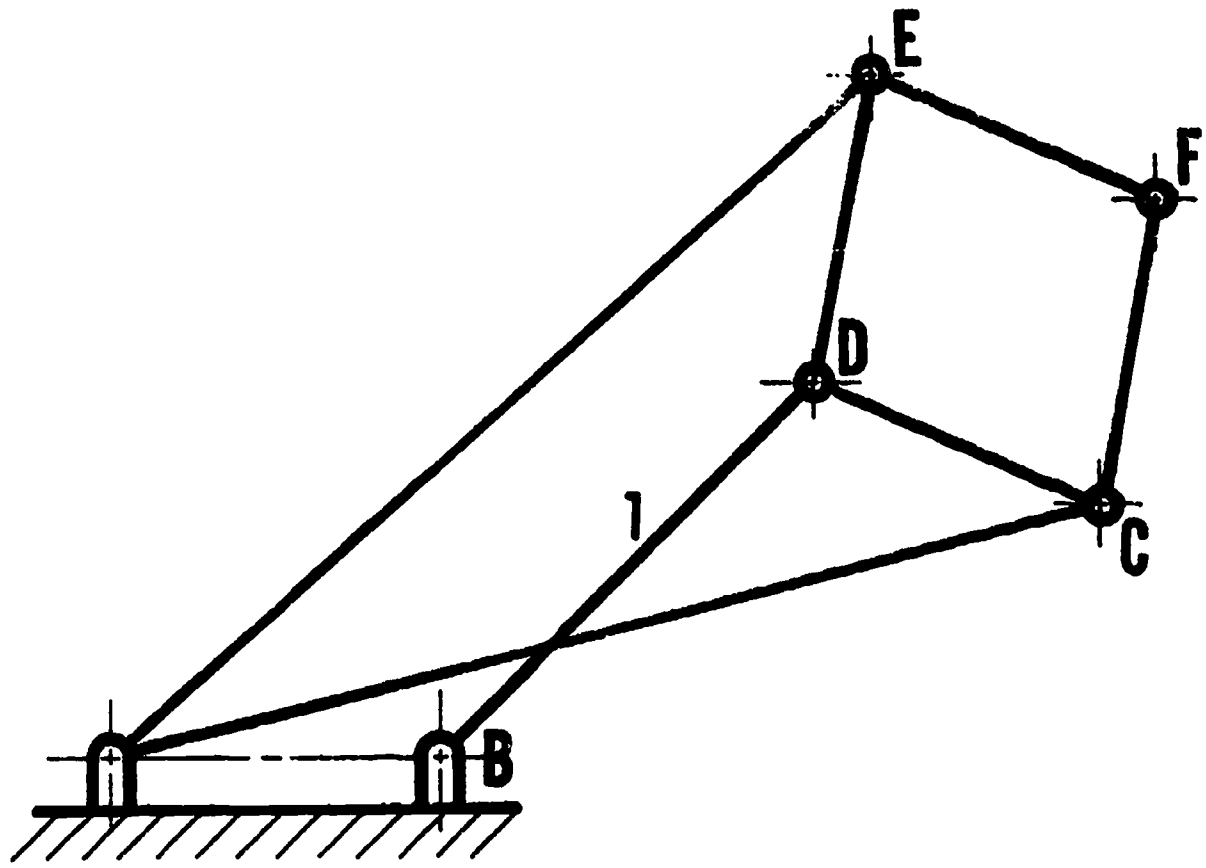
As line number ___(a)___ revolves about point "B", point "F" will make a ___(b)___ line path.



If line number 1 ($\overline{BD}$) is made longer than line number 8 ($\overline{AB}$), point "F's" curved path radius will be to the ___(a)___ of the mechanism on line ___(b)___ extended.



As line ___(a)___ revolves fifteen degrees
___(b)___ about point "B", points "D" and
___(c)___ move closer together.

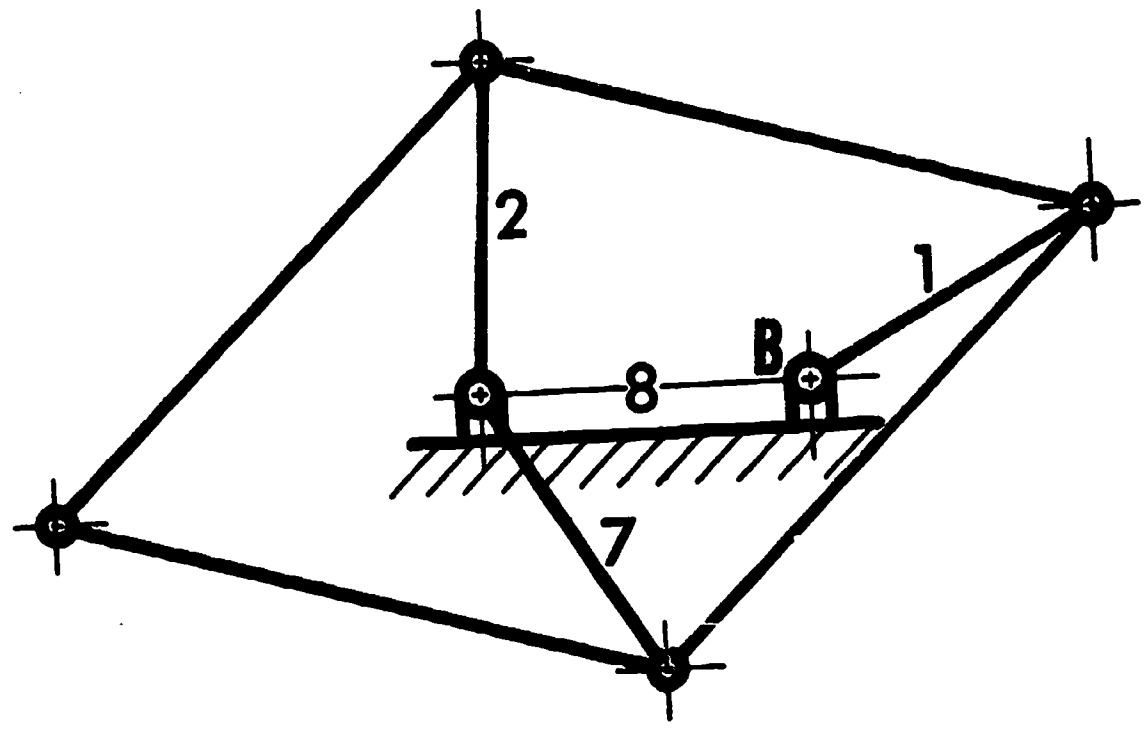


FRAME 14.23.

The third KINEMATIC form you are going to study is an INVERTED PEAUCELLIER'S mechanism. The illustration shows an inverted Peaucellier's mechanism. An INVERTED PEAUCELLIER'S mechanism is a linkage system in which links 1, 2, 7 and 8 are all equal. Link 8 is considered as the FIXED LINK or FRAME of the mechanism. Link 1 revolves about PIVOT POINT "B" and introduces motion into the mechanism. Link 1 is called the CRANK LINK.

In an INVERTED Peaucellier's mechanism links 7, _(a)_, _(b)_, and _(c)_ are _(d)_.

Link _(e)_ is considered the FIXED LINK of the mechanism and link _(f)_ is called the CRANK LINK. Link _(g)_ revolves about _(h)_ _(i)_ "B".

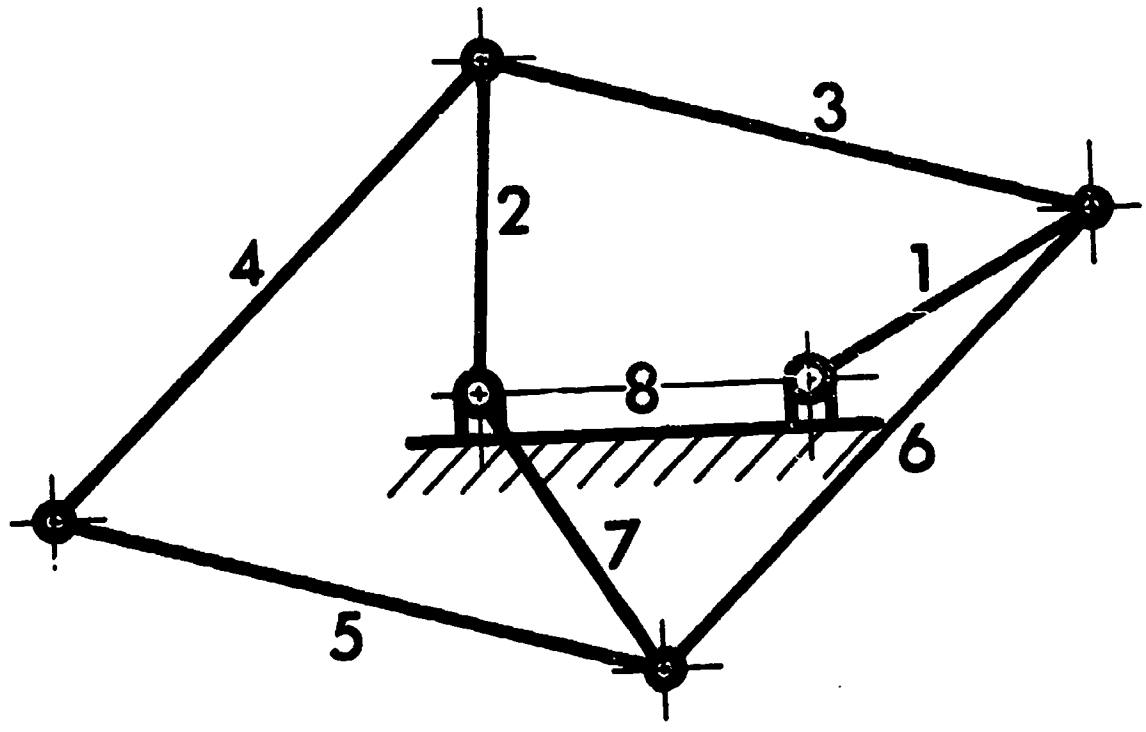


In the INVERTED PEAUCELLIER'S mechanism links 3, 4, 5 and 6 are equal and must be LONGER in length than links 1, 2, 7 and 8.

Links 6, _(a)_ _(b)_, and _(c)_ are equal.

Link 8 is always shorter than links _(d)_, _(e)_, _(f)_, and _(g)_.

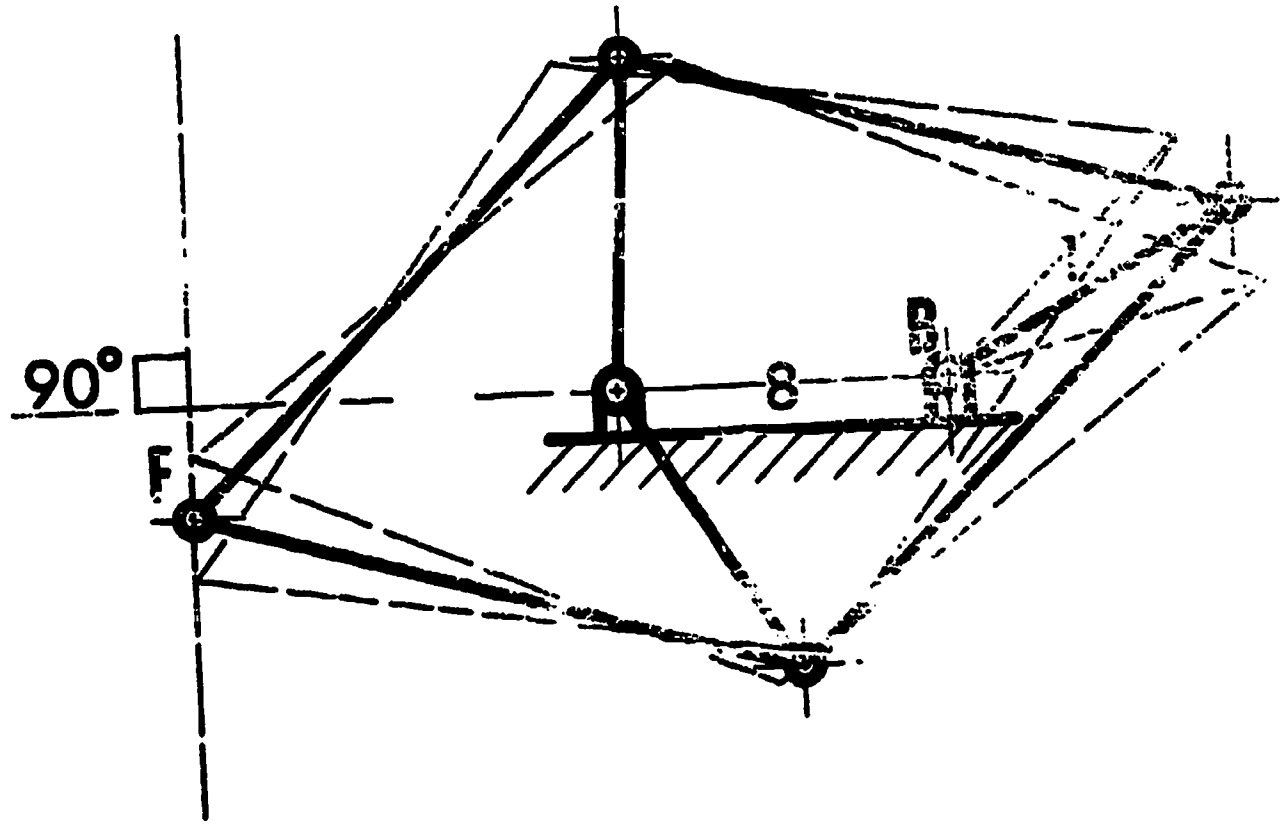
Link 3 is always _(h)_ than links 1 and 2.



As CRANK LINK 1 is revolved 15 degrees clockwise and 15 degrees counter-clockwise about pivot point "B". the path traced by LINKAGE POINT "F" is a straight line. The straight line path is PERPENDICULAR to FIXED LINK 8 extended to the LEFT.

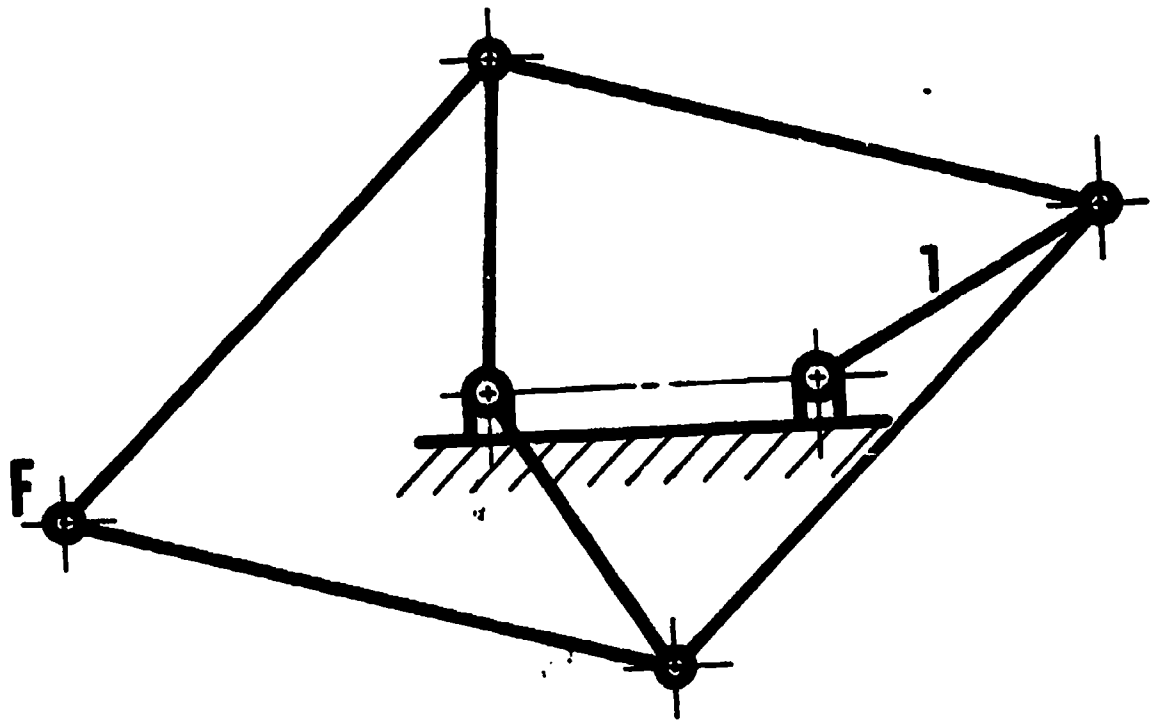
In an INVERTED PEAUCELLIER'S mechanism LINKAGE POINT __(a)__ will make a straight line path as __(b)__ LINK 1 revolves about __(c)__ POINT "B".

The straight line path that LINKAGE POINT __(d)__ makes is __(e)__ to FIXED LINK __(f)__ extended to the __(g)__.

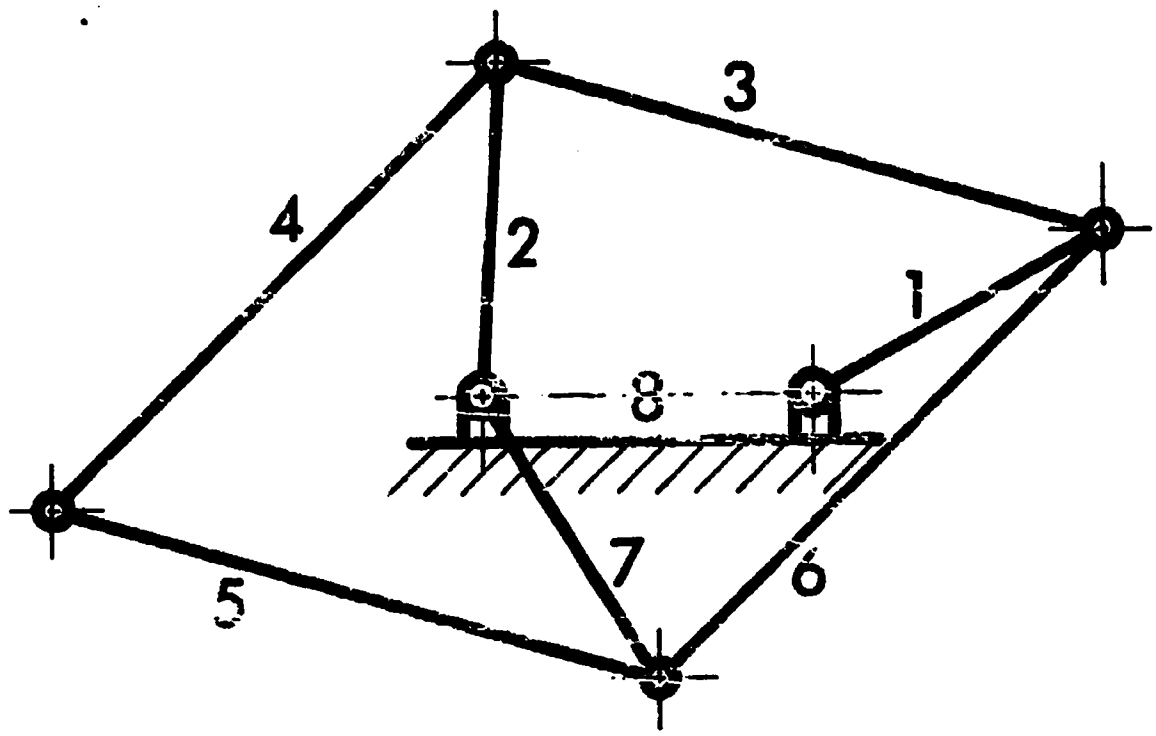


An INVERTED PEAUCELLIER'S mechanism is designed so that LINKAGE POINT "F" is always on the OPPOSITE side of the mechanism from the location of the input CRANK LINK 1.

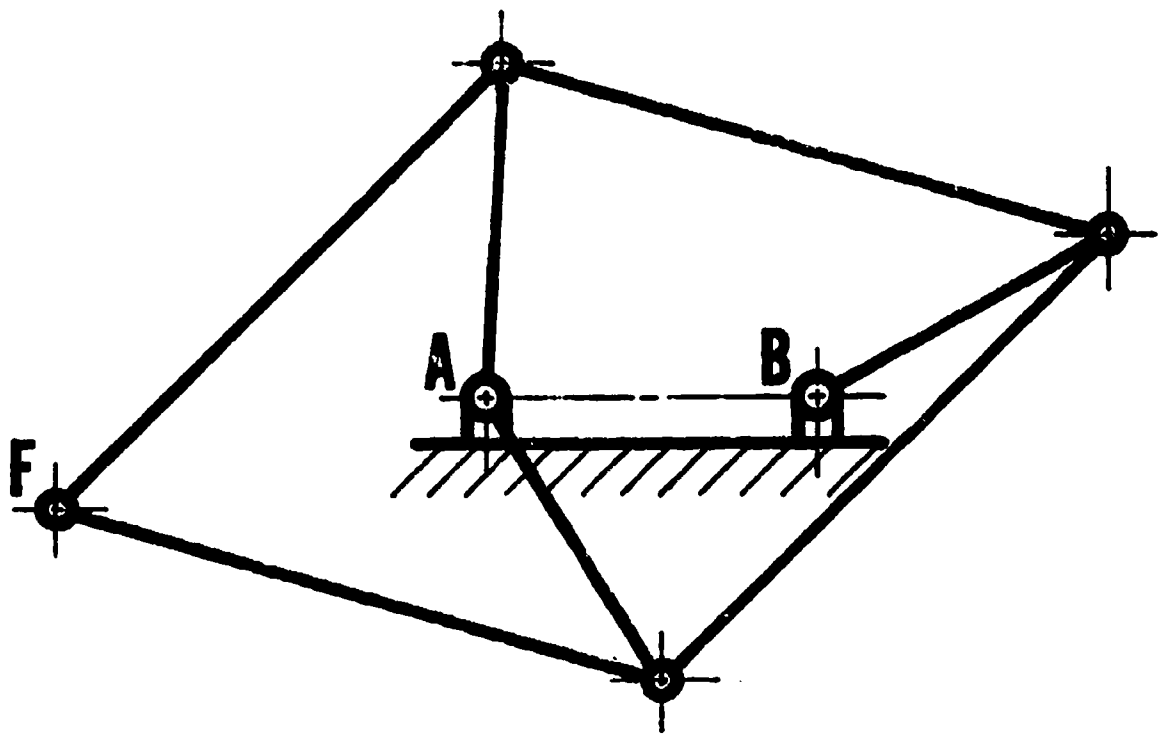
The path of LINKAGE POINT "F" in an _(a)_ _(b)_ mechanism is always on the opposite side from the input _(c)_ _(d)_ 1.



Lines 1 ($\overline{BD}$) and 7 ($\overline{AF}$) would be equal in length in a (an) ___(a)___ ___(b)___ mechanism

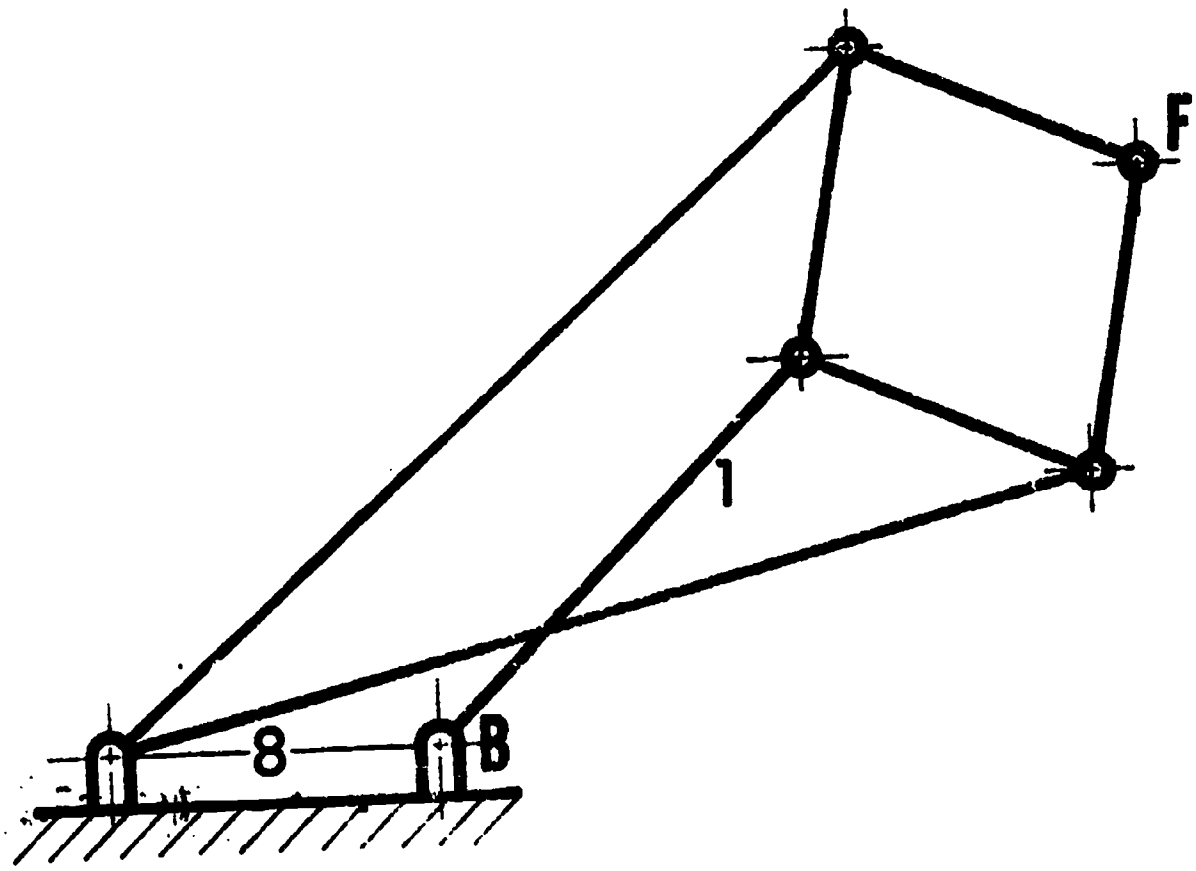


In a (an) ___(a)___ PEAUCELLIER'S mechanism point "F" would be to the left of points "A" and "B" as shown in the illustration.



FRAME 21.27.

A MODIFIED PEAUCELLIER'S mechanism makes an arc with its center on link 8 extended. In order to have LINKAGE POINT "F" move in some path, link 1 must revolve about pivot point "B". The problem dealing with the following illustration requires you to revolve CRANK LINK 1, 15 degrees clockwise and 15 degrees counterclockwise from the position shown. Accurately draw, with the instruments provided, the positions of each link in the mechanism for the two new positions of CRANK LINK 1. The problem sheet is the second to the last sheet of the answer sheets. Check your answer with the solution provided with the answer sheet. Congratulations, you should now be a first-class Peaucellier's mechanism designer!



NAME _____

DATE _____

SELF-INSTRUCTIONAL PROGRAM ANSWER SHEET

THE TIME IS NOW _____ (START)

1.(a) _____
(b) _____
(c) _____
(d) _____
2.2.(a) _____
3.3.(a) _____
(b) _____
(c) _____
(d) _____
(e) _____
(f) _____
(g) _____
(h) _____
(i) _____
(j) _____
(k) _____
(l) _____
(m) _____
(n) _____
4.4.(a) _____
(b) _____
(c) _____
(d) _____
(e) _____
(f) _____
(g) _____
(h) _____
(i) _____
(j) _____
5.5.(a) _____
(b) _____
(c) _____
(d) _____
6.6.(a) _____
(b) _____
(c) _____
(d) _____
(e) _____
(f) _____
(g) _____
(h) _____
(i) _____
(j) _____
7.7. (a) _____
(b) _____
8.8. (a) _____
(b) _____
(c) _____
(d) _____
(e) _____
(f) _____
8.8.1.(a) _____
(b) _____
(c) _____
(d) _____
8.8.2.(a) _____
8.8.3.(a) _____
8.8.4.(a) _____
(b) _____
9.9. (a) _____
(b) _____
(c) _____
(d) _____

10.10.(a) _____

(b) _____

(c) _____

11.11.(a) _____

(b) _____

12.12.(a) _____

(b) _____

(c) _____

13.13.(a) _____

(b) _____

(c) _____

(d) _____

(e) _____

13.14. NO

13.15. RESPONSE

13.16. REQUIRED

13.16.1.(a) _____

(b) _____

13.16.2.(a) _____

(b) _____

(c) _____

15.17.(a) _____

(b) _____

(c) _____

(d) _____

(e) _____

(f) _____

16.18.(a) _____

(b) _____

17.19.(a) _____

(b) _____

18.20.(a) _____

(b) _____

19.21.(a) _____

(b) _____

(c) _____

20.22.(a) _____

(b) _____

(c) _____

20.22.1.(a) _____

20.22.2.(a) _____

(b) _____

20.22.3.(a) _____

(b) _____

20.22.4.(a) _____

(b) _____

(c) _____

14.23.(a) _____

(b) _____

(c) _____

(d) _____

(e) _____

(f) _____

(g) _____

(h) _____

(i) _____

14.24.(a) _____

(b) _____

(c) _____

(d) _____

(e) _____

(f) _____

(g) _____

(h) _____

14.25.(a) _____

(b) _____

(c) _____

(d) _____

(e) _____

(f) _____

(g) _____

14.26.(a) _____

(b) _____

(c) _____

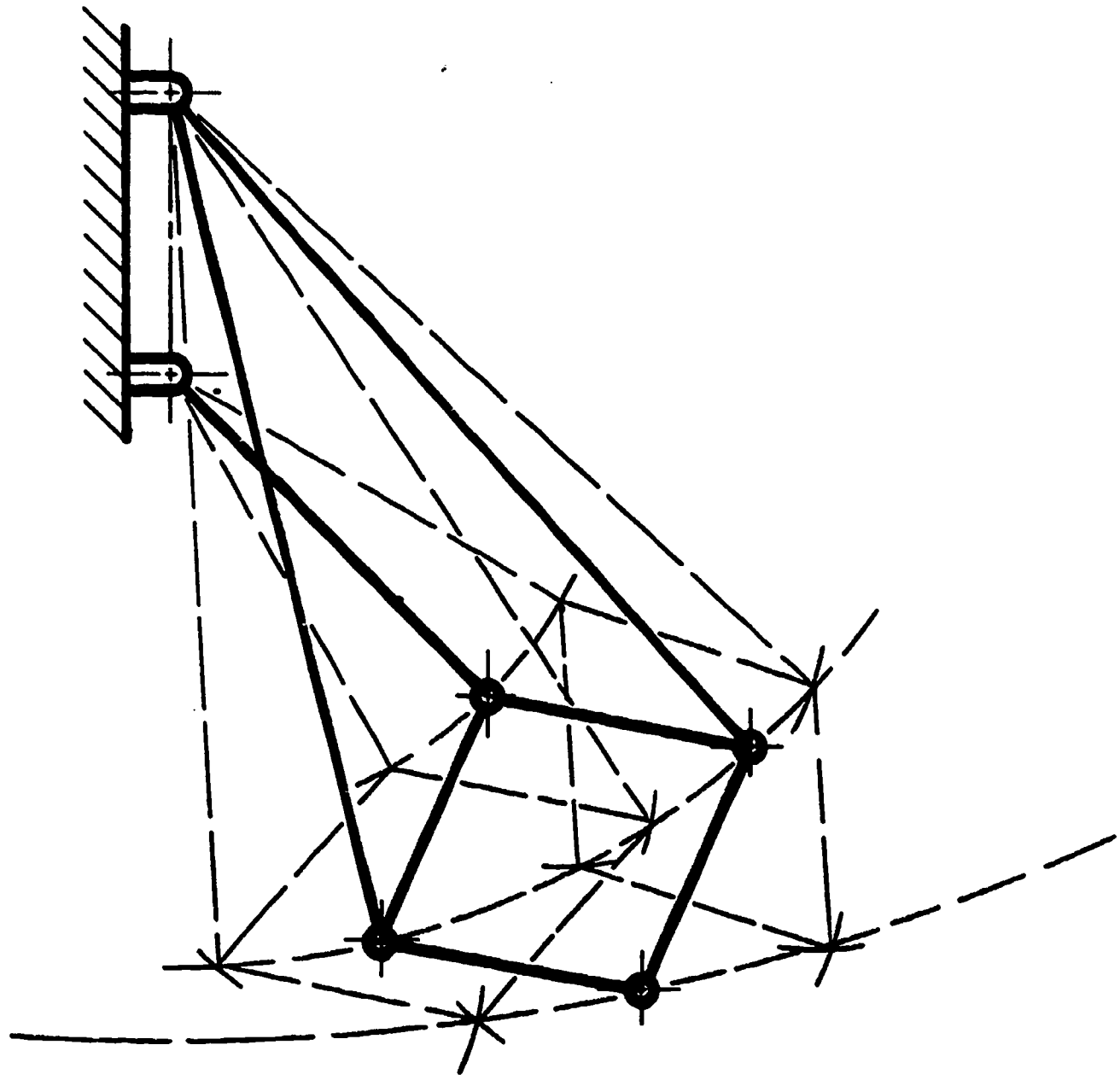
(d) _____

14.26.1. (a) _____

(b) _____

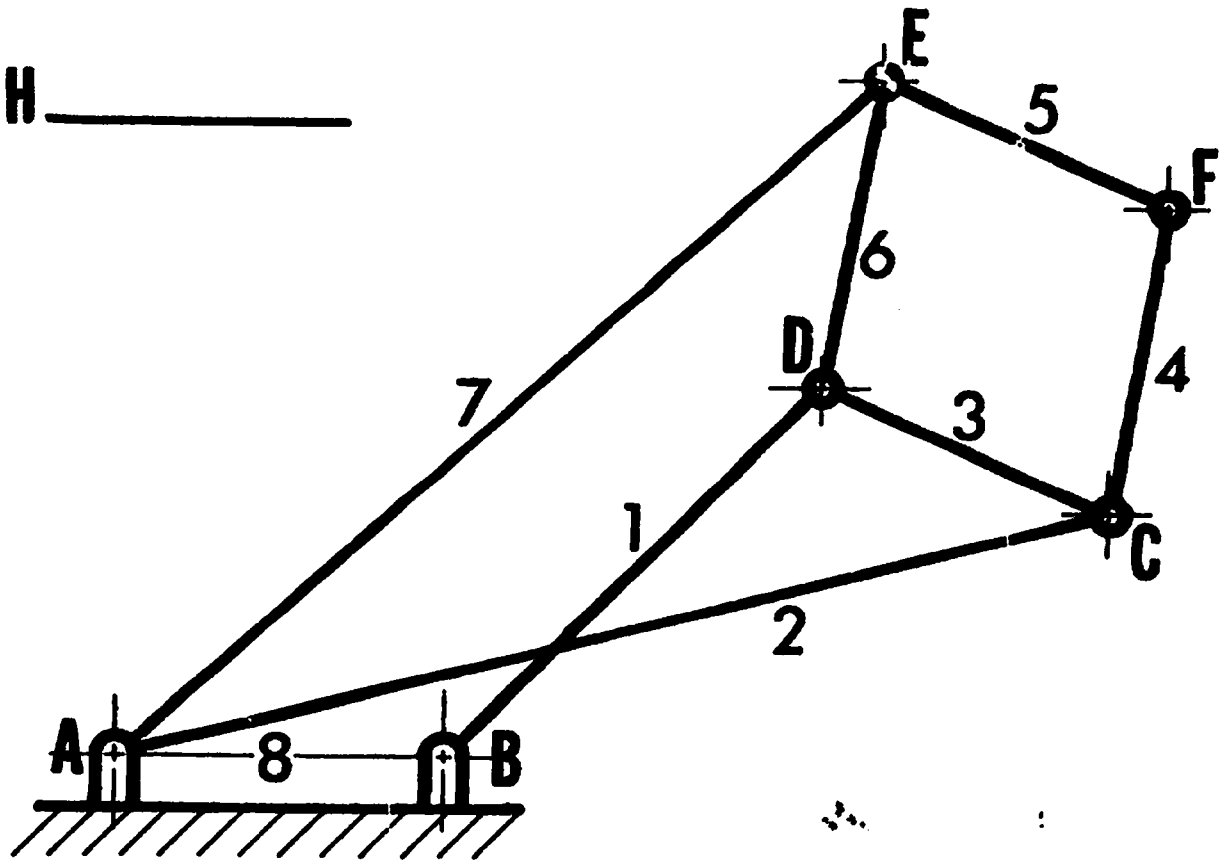
14.26.2. (a) _____

21.27. WORK THIS PROBLEM ON THE SHEET PROVIDED ON THE NEXT PAGE.



START_____

FINISH_____



LH

Name _____

I.D. No. _____

Date _____

POSTTEST

DIRECTIONS: The following illustration shows a mechanism. You are to complete the following statements by selecting the word or words which will make the statement correct. All of the questions deal with the mechanism illustrated. You will be required to complete a drawing for the first question. If you answer a question but are still in doubt about its correctness, place a question mark (?) on the line to the left of the item number. Record the starting and finishing times to the nearest minute in the space provided. You will have a maximum of 30 minutes for the test. Work each problem in order (1-13).

_____ 1. The problem dealing with the following illustration requires you to make a drawing with the drafting instruments provided. You are to revolve line 1 ($\overline{BD}$) fifteen degrees (15^{o}) clockwise and fifteen degrees (15^{o}) counter-clockwise about "B" from the position shown. Accurately draw the position of each line in the mechanism for the two new positions of line 1 ($\overline{BD}$). Show the line path of point "F".

Now start to work the following drawing problem. Indicate the starting and finishing times in the space provided on the drawing.

_____ 2. As line number _____ revolves about point "B", point "F" will make a _____ line path.

_____ 3. As line _____ revolves fifteen degrees _____ about point "B", points "D" and _____ move closer together.

_____ 4. If line number 1 ($\overline{BD}$) is made longer than line number 8 ($\overline{AB}$), point "F's" curved path radius will be to the _____ of the mechanism on line _____ extended.

_____ 5. In order to make the mechanism an unmodified mechanism the designer should make line number 1 ($\overline{BD}$) equal to line number _____.

_____ 6. In order to make point "F" move in a straight line path the designer must make lines 3 ($\overline{CD}$), _____, _____ and _____ equal.

_____ 7. In order to make point "F" move in a straight line path the designer must make lines 8 ($\overline{AB}$) and _____ equal.

_____ 8. Points "F", _____, _____ and _____ are classified as _____ points.

_____ 9. Points _____ and _____ are classified as pivot points.

_____10. Point "F" and "C" have _____ displacement.

_____ 11. Lines 1 ($\overline{BD}$) and 7 ($\overline{AE}$) have _____ displacement.

_____ 12. In a (an) _____ Peaucellier's mechanism point "F" would be to the left of points "A" and "B" as shown in the illustration.

_____ 13. Lines 1 ($\overline{BD}$) and 7 ($\overline{AE}$) would be equal in length in a (an) _____ _____ mechanism.

THE TIME IS NOW _____ (FINISH)
